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CHRONIC DUODENAL ILEUS

WITH REPORT OF FIFTY-SIX CASES

C. C. HIGGINS, M.D.
Fellow in Surgery, Cleveland Clinic
CLEVELAND

The relationship between acute dilatation of the stomach and duodenal obstruction by compression of the duodenum by the root of the mesentery has been recognized in late years and considerable literature has been devoted to the discussion of this condition. However, the clinical and pathologic manifestations of chronic obstruction of the duodenum have received but little attention.

During the last year several cases in which the symptoms and physical findings were more or less constant, and dilatation of the duodenum was revealed by roentgen-ray and fluoroscopic examination, have been studied in the Cleveland Clinic. As a result of this experience we have found that a careful inspection of the duodenum by the surgeon and a critical examination of the roentgenogram in certain obscure cases has led to a more frequent recognition of this condition, with the resultant alleviation of the symptoms by surgical intervention. This clinical study suggested a review of the literature pertaining to duodenal obstruction, and the findings in these investigations have suggested that it would be worth while to present the data that have led us to conclude that chronic dilatation of the duodenum is a clinical entity.

The earliest article in the literature regarding duodenal obstruction was written by Boernerus [1] in 1752, but in it he referred to the work of Alsies and Sylvester on chronic obstruction of the duodenum. In 1820 Yeats [2] published a paper in which he recognized the possibility that obstruction of the duodenum might be produced by the transverse colon, and he also discussed the symptomatology of this condition. In 1829 Guyot [3] reported a case of congenital obstruction of the duodenum. In

1. Boernerus, cited by Kellogg, E. L., and Kellogg, W. A.: Chronic Duodenal Obstruction with Duodenojejunostomy as a Method of Treatment, Ann. Surg. **73**:578-608 (May) 1921.

2. Yeats, G. D.: Some Observations on the Duodenum, with Plates Descriptive of Its Situation and Connections, Tr. Coll. Phys., London **6**:325-378, 1820.

3. Guyot: Congenital Contraction of the Duodenum, Bull. Soc. anat. de Paris **3**:71, 1820.

1848 Anderson [4] discussed the condition, and in 1849 von Rokitansky [5] described the relationship between acute dilatation of the stomach and obstruction of the duodenum by the root of the mesentery.

In 1853 further reports were made by Miller and Humby,[6] their work also dealing with acute dilatation of the stomach. In 1852 Fagge [7] presented a series of cases of duodenal obstruction and acute dilatation of the stomach, and in 1855 articles were published by Bamberger [8] and Heschl,[9] the former dealing with acute dilatation of the stomach and the latter with obstruction of the duodenum by the root of the mesentery.

Mesenteric ileus was again described in 1855 by Glenard,[10] who suggested that a narrowing of the duodenojejunal boundary might be caused by traction in cases of acute dilatation of the stomach. The relationship of acute dilatation of the stomach to duodenal obstruction was again discussed by Brinton [11] in 1859. In 1890 Albrecht [12] observed a flattening of the duodenum between the root of the mesentery and the spine, and he reported a series of experiments and observations that will be discussed later.

In 1891 Kundrat [13] reported three cases of mesenteric obstruction, and Schnitzler [14] also described this condition in 1895. In 1900 Robinson [15] discussed arteriomesenteric ileus and gave clinical and necropsy findings. In the same year Petit [16] reported a case of duodenal obstruction that was attributed to mesenteric interference.

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4. Anderson, J. C.: Stricture of the Duodenum, New Orleans M. & S. J. **5**:480, 1848-1849.

5. Von Rokitansky, C.: Lehrbuch der pathologischen Anatomie, Vienna, **3**, 1863.

6. Miller and Humby, cited by Laffer, W. B.: Acute Dilatation of the Stomach and Arteriomesenteric Ileus, Ann. Surg. **47**:390-416, 532-557, 1908.

7. Fagge, H., cited by Kellogg and Kellogg (Footnote 1).

8. Bamberger, cited by Laffer (Footnote 6).

9. Heschl, R., cited by Laffer (Footnote 6).

10. Glenard, F.: De l'enteroptose, Presse méd. **41**:57-61, 1889.

11. Brinton, W., cited by Laffer (Footnote 6).

12. Albrecht, P. A.: Ueber arterio-mesenterialen Darmverschluss an der Duodeno-Jejunalgrenze und seine ursächliche Beziehung zur Magenerweiterung, Arch. f. path. Anat. **156**, 1899.

13. Kundrat, cited by Conner, L. A.: Acute Dilatation of the Stomach, and Its Relation to Mesenteric Obstruction of the Duodenum, Am. J. M. Sc. **133**: 345-373, 1907; Tr. A. Am. Phys. **21**:579-617, 1906.

14. Schnitzler, cited by Conner (Footnote 13).

15. Robinson, B.: Dilatation of the Stomach from Pressure of the Superior Mesenteric Artery, Vein and Nerve on the Transverse Segment of the Duodenum, Am. Pract. & News **30**:124-128, 1900; also Cincinnati Lancet-Clinic **45**:577-586, 1900.

16. Petit, L. A., cited by Kellogg and Kellogg (Footnote 1).

A monograph of forty-four cases of duodenal obstruction was published by Thomson [17] in 1902. In 1905 Neck [18] reviewed forty compiled cases and in the same year Mayo [19] also discussed this condition.

In 1905 Ochsner [20] described the presence of a sphincter in the duodenum and Zade [21] discussed postoperative mesenteric ileus. In 1907 Bloodgood [22] discussed this condition and Barker [23] emphasized the diagnostic value of testing the vomitus for bile and pancreatic juices. In 1906 Lewis Conner [24] described the relationship between acute dilatation of the stomach and obstruction of the duodenum by the root of the mesentery, and in 1906 Finney [25] discussed the relation of gastric disturbances to dilatation of the duodenum.

In 1908 Laffer [26] reviewed the literature up to that time, including the compiled reports of 217 cases. In the same year Codman [27] described a case of chronic obstruction of the duodenum by the root of the mesentery. In 1910 Stavely [28] also published an article on chronic gastromesenteric ileus and its treatment.

Megaduodenum was discussed by Corwin [29] in 1915, another paper on this subject by Dorrance and Deaver [30] appearing in the same year.

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17. Thomson, H. C., cited by Laffer (Footnote 6).

18. Neck: Die akute Magenerweiterung Sammelreferat, Centralbl. f. d. Grenzgeb. d. Med. u. Chir. **8**:561-609, 1905.

19. Mayo, W. J.: Chronic Ulcer of the Stomach and Duodenum from a Surgical Standpoint with Some Remarks on Gastric Fever, South. M. & S. J. **3**:1-5, 1905; abstr. J. A. M. A. **45**:1211, 1905.

20. Ochsner, A. J.: Further Observations on the Anatomy of the Duodenum, Am. J. M. Sc. **132**:1-8, 1906.

21. Zade, H.: Ueber postoperativen arteriomesenterialen Darmverschluss an der Duodeno-Jejunalgrenze und seinen Zusammenhang mit akuter Magendilatation, Beitr. z. klin. Chir. **46**:388-404, 1905.

22. Bloodgood, J. C.: Acute Dilatation of the Stomach; Gastromesenteric Ileus, Ann. Surg. **46**:736-762, 1907.

23. Barker, in discussion on Finney, J. M. T.: The Relation of Dilatation of Duodenum to Gastric Disturbances, Bull. Johns Hopkins Hosp. **17**:37-38, 1906.

24. Connor (Footnote 13).

25. Finney, J. M. T.: Gastromesenteric Ileus, Boston M. & S. J. **155**:107-113, 1906.

26. Laffer, W. B.: Clinical Notes on Acute Dilatation of the Stomach, or Arteriomesenteric Ileus, Ohio M. J. **4**:69-77, 1908.

27. Codman, E. A.: Chronic Obstruction of the Duodenum by the Root of the Mesentery, Boston M. & S. J. **158**:503-510, 1908.

28. Stavely, A. L.: Chronic Gastromesenteric Ileus, Surg., Gynec. & Obst. **11**:288-297, 1910.

29. Corwin, R. W.: Megaduodenum, Colorado Med. **12**:138-141, 1915.

30. Dorrance, G. M., and Deaver, J. B.: Gigantic Duodenum Due to Kinking at Duodenal Jejunal Junction, Associated with Dilatation of the First Portion of the Jejunum; Gastro-Enterostomy and Fistula from the Jejunum into the Transverse Colon, Internat. Clin. **2**:238-259, 1915.

The operation of duodenojejunostomy was discussed by Downes [31] in 1918, and in 1920 Crouse [32] published a paper in which he reported cases of chronic duodenal obstruction. Dilated duodenum was discussed by Vanderhoof [33] in the same year, and in 1918 Engelbach [34] described arteriomesenteric occlusion of the duodenum.

Articles describing duodenal obstruction were published by Kellogg [35] in 1919, by Kellogg [36] and by Wilkie [37] in 1921, by Hurst [38] and by Quain [39] and Reinhard in 1922. An article on chronic mesenteric obstruction of the duodenum by Tinkham [40] appeared in 1923, and in the same year Braun [41] discussed the association of that condition with acute dilatation of the stomach.

In 1925 Robertson [42] published an article on acute dilatation of the stomach, with a consideration of chronic duodenal ileus in which he cast a doubt on the association of this condition with obstruction by the mesenteric root. Undoubtedly he is correct as not all cases are due to this. The various conditions that may cause it will be discussed later.

In 1925 Devine [43] published an excellent article on "Basic Principles and Supreme Difficulties in Gastric Surgery," in which he also discussed dilatation of the duodenum and suggested that it is caused by a

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31. Downes, W. A.: Duodenojejunostomy, Ann. Surg. **68**:94, 1918.

32. Crouse, H.: Chronic Duodenal Dilatation, Its Concomitant and Sequential Pathology, Arch. Surg. **1**:538-563 (Nov.) 1920.

33. Vanderhoof, D.: Dilated Duodenum, J. A. M. A. **69**:510-515 (Aug. 18) 1917.

34. Engelbach, W.: Arteriomesenteric Occlusion of the Duodenum, J. Roentgenol. **1**:45-65 (May) 1918.

35. Kellogg, E. L.: Diagnosis and Treatment of Chronic Duodenal Obstruction, Surg., Gynec. & Obst. **28**:174-182 (Feb.) 1919; Duodenal Obstruction with Duodenojejunostomy, Med. Rec. **95**:215, 1919.

36. Kellogg (Footnote 1).

37. Wilkie, D. P. D.: Chronic Duodenal Ileus, Brit. M. J. **2**:793-795 (Nov. 12) 1921.

38. Hurst, A. F.: Chronic Obstruction of the Duodenum by Mesenteric Vessels, Guy's Hosp. Rep. **72**:436-440 (Oct.) 1922.

39. Quain, E. P.: Chronic Duodenal Obstruction; Etiology, Symptoms and Treatment, Journal-Lancet **42**:575-579 (Dec. 1) 1922.

40. Tinkham, H. C.: Chronic Arteriomesenteric Obstruction of Duodenum, Boston M. & S. J. **188**:397-401 (March 22) 1923.

41. Braun, A.: Mesenteric Arterioduodenal Occlusion and Acute Dilatation of Stomach, Beitr. z. klin. Chir. **128**:103-141, 1923; abstr., J. A. M. A. **80**: 1185 (April 21) 1923.

42. Robertson, G.: Acute Dilatation of Stomach and Intestinal Tube with Consideration of "Chronic Duodenal Ileus," Surg., Gynec. & Obst. **40**:206-213 (Feb.) 1925.

43. Devine, H. B.: Basic Principles and Supreme Difficulties in Gastric Surgery, Surg., Gynec. & Obst. **40**:1-16 (Jan.) 1925.

derangement of the neuromuscular mechanism. The lack of hypertrophy can be explained by the fact that the duodenum is not doing work that cannot be overcome and the obstruction is not constantly present. Either regurgitation through the pylorus occurs or the food passes into the jejunum with postural change. That he was securing adequate drainage is shown by the small, contracted pylorus. The tone of the duodenum was lost owing to constant overstretching and impaired physiologic activity.

The embryologic development of the duodenum with its intimate relationship to contiguous structures makes it peculiarly liable to pathologic deviations from the normal. A review of the embryology of the duodenum makes it evident that considerable variation occurs before it attains its final and permanent relation to other structures. Perhaps the most striking example of this is its gradual immobilization. In the early stages of development the duodenum is quite mobile and the mesentery is considerably longer than when development is completed, thus allowing freer movement. As development continues the duodenum is drawn into position by the dorsal and ventral mesogastrium. The mesentery is then very short and the duodenum becomes fixed dorsally by the retroperitoneum.

Moreover, as the body grows the retroperitoneum becomes shortened and the duodenum is still further immobilized, and its permanent position is altered by adjacent structures, such as the pancreas or its ligamentous attachments. In 1897 Dwight [44] made a series of wax casts of the duodenum which are still in the Harvard Museum. At that time he recognized the U, the V, the ring, the C, the triangular, and the S shaped duodenum. Many of these casts show on the anterior superior surface a groove caused by the pressure of the superior mesenteric artery. Many of the casts also show a groove on the posterior surface of the transverse portion due to pressure of the spine. An angulation also is present at the point where the duodenum joins the jejunum.

Anatomically the duodenum is divided into three parts (Fig. 1, A). The first portion is normally slightly movable, and is partially covered by peritoneum. The head of the pancreas is intimately related to the distal end of this part and also to the first portion of the second part. The second part of the duodenum is covered by the transverse colon and is fixed posteriorly by the retroperitoneum. The third part passes under the root of the mesentery, is in close proximity to the spine, and is also fixed posteriorly by the retroperitoneum. In 1905 Ochsner [45] described

44. Dwight, Lewis: Notes on the Duodenum and Pylorus, J. Anat. & Physiol. **31**:516-521, 1896-1897.

45. Ochsner, A. J.: Constriction of the Duodenum Below the Entrance of the Common Duct and Its Relation to Disease, Tr. Am. S. A. **23**:314-322, 1905.

a concentration of the circular muscle fibers in the duodenum from 2 to 3 cm. aboral to the ampulla of Vater, and he discussed the relationship of this sphincter to the pylorus and ileocecal valve.

In the process of evolution, variation in the position of the organs occurred when the upright position was assumed. This is well illustrated in the quadrupeds in which the intestines are supported by the ventral

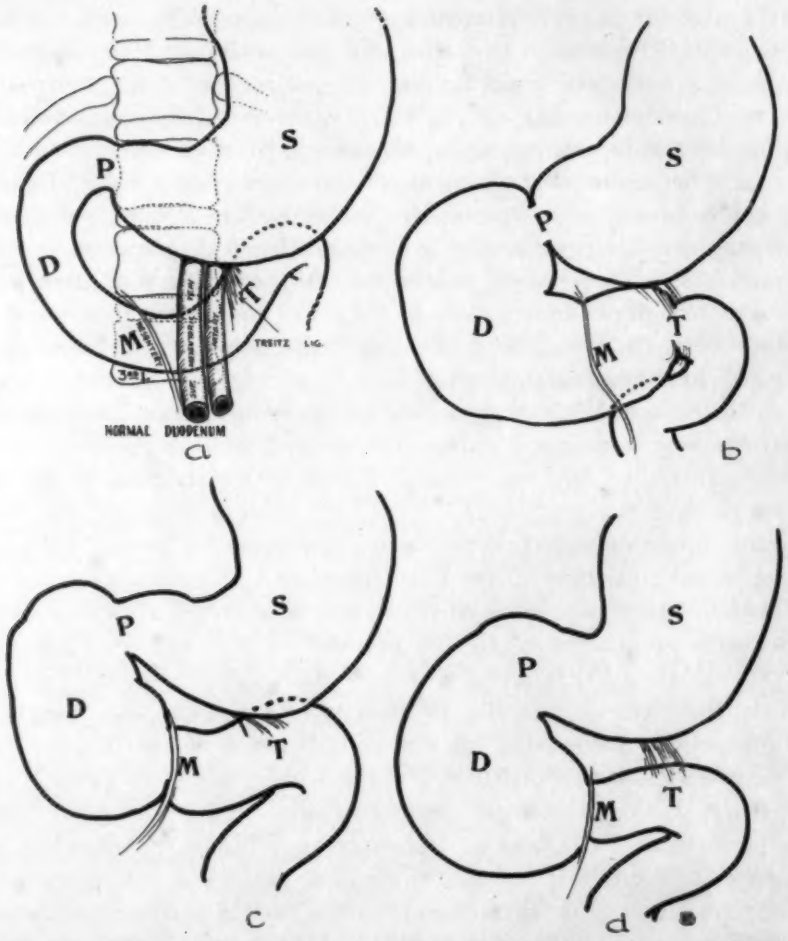

Fig. 1.—Dilatation of the duodenum: *a*, normal duodenum; *b*, dilated duodenum with normal size pylorus; *c*, dilated duodenum with moderate dilatation of pylorus; *d*, dilated duodenum with marked dilatation of pylorus; *P*, pylorus; *M*, mesentery; *T*, Treitz's ligament; *S*, stomach, and *D*, duodenum.

abdominal wall. When the upright position was assumed certain factors had to develop to compensate for this change. If there were no alterations the entire weight of the organs would be on the mesentery. Thus, the mesentery became longer in order that the intestines might rest

on the floor of the abdomen and thus relieve the mesentery and blood vessels from bearing the entire weight.

The mesentery of the duodenum can be readily studied in the cadaver. Its root is seen to extend from the left side of the second lumbar vertebra downward and to the right toward the right sacro-iliac synchondrosis or the iliac fossa. Between the leaves of the mesentery are the superior mesenteric vessels and nerves and, as Codman states, the root of the trunk of the superior mesenteric artery as it passes from the aorta between the third part of the duodenum and the pancreas. Many investigations have been made to determine the point where the duodenum crosses the spine. Fawcett and Blackford [46] state that it may cross anywhere between the upper border of the second lumbar vertebra down to the disk between the fifth lumbar vertebra and the first sacral, but it will most commonly be found opposite the third lumbar vertebra. It tends to cross lower in females than in males.

ETIOLOGY

When we are considering the etiology of dilatation of the duodenum it should be borne in mind that any or all of the respective parts of the duodenum may be involved. Various conditions have been considered to be factors that cause predisposition to this condition. Four chief groups of these possible causative factors may be considered:

1. Congenital abnormalities.
2. Factors favoring the formation of adhesions.
3. Factors favoring compression of the duodenum.
4. Factors favoring a pelvic position of the intestines.

Congenital malformations, such as atresia of one of its portions, may cause dilatation of the duodenum. However, these cases are comparatively rare. Cases of so-called idiopathic dilatation in infants can be eliminated only by careful exploration of the abdominal viscera. After careful examination the presence of an abnormality can usually be demonstrated.

In considering factors that favor the formation of adhesions, it should be remembered that the first or the first and second portions of the duodenum are usually involved. Chronic cholecystitis may favor adhesions to the contiguous structures. If adhesions form between the gallbladder and the duodenum, angulation may occur with the production of gradual obstruction of the duodenum. The angulation between the first and the second parts of the duodenum produces an obstruction with

46. Fawcett, E., and Blackford, J. V.: Some Observations on the Level at Which the Lower Border of the Third Part of the Duodenum Crosses the Vertebral Column, J. Anat. & Physiol. **38**:435-437, 1903-1904.

subsequent dilatation proximal to the point of obstruction. Adhesions between the first and the second portions of the duodenum and the hepatic flexure will produce a similar condition. Similarly, cases of gastroptosis without enteroptosis, or the latter only, to a small degree will give a similar picture, especially if the retroperitoneal attachment of the duodenum is unaltered.

This was well demonstrated in the experiments cited by Conner. In his work he removed the small intestines from ten cadavers. The mesentery was gathered en masse and fastened to a cord which passed into the pelvis and out through the anus. Various weights were then attached to the cord, by which the tension on the mesentery could be increased or decreased at will. The stomach and duodenum were then filled with water and the pressure necessary to overcome the obstruction produced by traction on the mesentery was measured by means of a tube connected with a mercury manometer.

He attributed three cases of obstruction in which a degree of gastroptosis existed to the weight of the stomach on the duodenum. The other conditions discussed by him will be mentioned later.

Deaver states that a degree of dilatation is occasionally seen in gastric and biliary infections.

A pathologic condition of the pancreas may also be an etiologic factor as the first portion of the second part of the duodenum is pressed on by the pancreas. Thus, for example, a cyst of the pancreas might press on the duodenum and in some cases eventually produce obstruction with subsequent dilatation. Adhesions following operations may be a causative factor as is well illustrated in one of our cases (Case 42).

Devine's recent "neuromuscular" theory must also be considered. The nerve supply of the duodenum is derived from the celiac axis of the sympathetic. The parasympathetic systems are found in the plexus of Meissner and Auerbach. Since Royle and Hunter demonstrated the effect of sympathectomy on plastic tone, perhaps a continuation of this work on the viscera would illuminate the cause of vague intestinal pains. However, most of the cases present a definite obstruction that accounts for the proximal dilatation.

Many factors may favor compression of the duodenum, namely, lordosis; abnormally low position of the duodenum (in women); heavy mesentery; congenital spinal deformity; insertion of root of mesentery, and excessive motility of the proximal colon (congenital factor).

From the study of Dwight's casts of the duodenum, it can readily be seen that the flattening on the anterior surface was due to the pressure of the superior mesenteric artery, and that likewise the groove on the posterior surface (transverse portion) was formed by pressure from the spine or the spine and aorta.

Albrecht demonstrated very clearly that complete occlusion of the duodenum could be produced by traction on the mesentery. This was readily shown by placing the cadaver in the dorsal position and then inserting the finger into the duodenum. The mesentery was then pulled down and backward and complete occlusion was produced at the point where the mesentery and superior mesenteric artery traversed the duodenum. Albrecht stated also that traction would be produced in this direction if the small intestines occupied the pelvis.

In cases in which lordosis is present, the distance between the mesenteric root and the spine will be diminished, thereby favoring compression between the latter and the superior mesenteric artery. As stated previously the anterior curvature of the lumbar spine is greatest in the region of the fourth lumbar vertebra, and also the duodenum usually crosses the spine in the region of the third lumbar vertebra. Thus, if the duodenum crosses the spine lower down in the region of the fourth lumbar vertebra it would be more liable to compression than if it crossed where the anterior curvature is less. In cases of enteroptosis, especially in females, the significance of this can be readily comprehended, for as I stated previously, the duodenum tends to cross the spine at a lower level in females than in males. It may likewise be readily understood how a heavy mesentery would tend to produce obstruction. That is, if the root of the mesentery is heavy and short, compression of the duodenum between the superior mesenteric artery and the spine is favored.

Codman states, however, that there is less pressure on the duodenum in obese than in thin people for the fat in the mesentery tends to distribute the pressure, while in thin people the superior mesenteric artery presses the duodenum directly against the spine. Congenital spinal deformities that tend to increase the anterior curvature also favor compression, as in the case of lordosis.

The importance of the insertion of the root of the mesentery has been emphasized chiefly by Schnitzler who stated that if the mesentery was inserted to the right of the median line, compression of the duodenum by the root of the mesentery is more liable to occur than if it is inserted to the left of the median line. That the point of insertion of the mesentery does actually vary has been demonstrated in cadavers.

Excessive mobility of the proximal colon also may favor duodenal obstruction. One of the causes to which is ascribed the production of coloptosis is the fact that the fetal mesentery is too short. As Quain has stated, the right colon is often quite mobile. The high colon, i. e., the portion that includes the cecum and the hepatic flexure are supported by the mesentery, the right colon not being firmly attached to the posterior abdominal wall. The root of the mesentery is normally

attached above the duodenum and bears the weight of the cecum, ascending colon and hepatic flexure. The colica media artery is in this structure and under certain instances may be sufficiently tense to produce obstruction of the third portion of the duodenum. This applies, of course, to conditions in which the weight on the mesentery is sufficient to render the artery quite taut, especially coloptosis of the right colon.

In considering the fourth group of factors associated with and favoring arteriomesenteric obstruction, that is, those which are due to a pelvic position of the intestines, we have considerable evidence to substantiate our conclusions.

As demonstrated by Albrecht, traction applied to the mesentery in the direction of the axis of the pelvis would produce obstruction of the duodenum. In cases of enteroptosis in which the small intestines occupy the pelvis, traction would be ideally exerted on the mesentery. Conner reached a similar conclusion, as in his experiment described above he found that in some cases traction on the mesentery by a weight of 500 gm. would cause complete occlusion. This is approximately the weight of the small intestines. In his experiment the traction on the mesentery was exerted in the same direction as would be the case if the intestines occupied the pelvis, and he found also that a pressure of from 10 to 48 mg. was sufficient to overcome the obstruction. Conner concluded, therefore, that in certain individuals, obstruction of the duodenum could be produced by a pull on the mesentery equivalent to that exerted if the intestines occupied the pelvis and traction was applied in the same direction.

Türck,[47] on the other hand, believed that dilatation was a biologic problem and could not be explained simply by mechanics, and Barker [48] presented a different point of view as he found that dilatation of the proximal duodenum might be present in cases of incomplete obstruction of the cecal ileum, suggesting the question as to whether the mechanism was neuromuscular or mechanical. Bircher [49] considers duodenal ileus to be a clinical entity due to obstruction at the mesenteric slit. Frank [50] reported two cases of congenital atresia of the duodenum.

The majority of other investigators attribute the condition to mesenteric occlusion. It is necessary then to determine what are the factors that favor the descent of the intestines into the true pelvis, thus promoting traction on the mesentery. The most potent of these factors are

47. Türck, cited by Vanderhoof (Footnote 33).

48. Barker, W. H.: Dilatation of the Duodenum, Ann. Surg. **62**:433-440, 1915.

49. Bircher, E.: Der duodeno-jejunale Darmverschluss ein selbständiges Krankheitsbild Vorlaüfige Mitteilung, Zentralbl. f. Chir. **3**:843-846, 1912.

50. Frank, E. S.: Ueber chronischen arteriomesenterialen Verschluss des Duodenums im Kindesalter, Ztschr. f. Kinderh. **9**:99-103, 1913.

the following: iliac stasis, dilated cecum, visceroptosis, lax abdominal walls, a mesentery that is just long enough to allow the intestines to occupy the pelvis, but short enough to exert traction on the mesentery.

Iliac stasis is undoubtedly at times instrumental in forcing the small intestines into the pelvis. As shown by Jordan, the terminal coils of the ileum are normally above the pelvis but in stasis they sink into the pelvis and exert traction on the mesentery. Bloodgood found the cecum dilated and displaced into the pelvis in five cases. In cases of visceroptosis traction on the mesentery by the intestines in the pelvis is often sufficient to produce incomplete or complete obstruction of the duodenum.

In asthenic people with lax abdominal walls, the viscera do not have their normal support and descent of the intestines into the pelvis frequently occurs. As Mills has shown, this occurs more frequently in women.

Abnormal length of the mesentery also may be associated with occlusion of the duodenum. It may be readily understood that if the mesentery is of sufficient length to allow the intestines to occupy the pelvis, but not long enough for them to be supported by the pelvic floor, the entire weight will be borne by the mesentery, and this weight is easily sufficient to produce obstruction.

Conner considers that dorsal decubitus and the intestines practically devoid of feces and gas are contributing factors.

I believe the cause of traction on the mesentery varies in the individual case and the etiologic factor can often be ascertained only at the operating table.

In the absence of adhesions occlusion of the third part of the duodenum is usually due to arteriomesenteric pressure.

INCIDENCE

Chronic duodenal ileus occurs more frequently in females than in males. The condition may occur at any age, the highest incidence being perhaps during middle age. It is of rather infrequent occurrence in children unless it is associated with some congenital abnormality.

SYMPTOMATOLOGY

In considering the symptomatology of duodenal ileus the cases may be divided into two principal groups, those with complete obstruction and those with incomplete obstruction.

The cases of complete obstruction are often associated with acute dilatation of the stomach. The condition is usually found in postmortem examinations of patients who have died from acute dilatation of the stomach. The patient becomes nauseated from twelve to seventy-

two hours after operation or the nausea following anesthesia may be prolonged. The abdomen becomes markedly distended and the patient vomits large amounts of bile stained fluid and may complain of epigastric pain and discomfort. The pulse rate and respirations increase in frequency. Prostration and anhydremia ensue and death follows. These cases are spectacular and the rapid progress can hardly be comprehended.

In the majority of cases, however, the obstruction is incomplete and the attacks of distress may simulate gallbladder infection or gastric ulcer. The patient may complain of indigestion for years with a sense of fulness two or three hours after meals, the amount or degree of pain often depending on the condition of the pyloric sphincter. If this maintains its tone and is not dilated there is little vomiting, as the liquids do not regurgitate into the stomach and eventually pass into the jejunum when sufficient pressure is attained. Thus, considerable pressure on the pylorus occurs and pain ensues. If the pylorus is dilated, however, regurgitation of food from the duodenum into the stomach occurs, vomiting follows and there is little pain. Thus, one feature of the condition may be early pain, which is later replaced by vomiting with little pain.

The attacks are usually associated with intense headaches, often frontal or temporal in character; these are alleviated after vomiting occurs. For this reason in many cases the diagnosis of migraine has been made.

Intervals of freedom from these attacks of headache and vomiting may last from two to several days, the patient meanwhile feeling comparatively well. Then another attack occurs without any relation to the quantity or kind of food ingested. The bowels are costive. The attacks gradually become more frequent as the duodenum and pylorus dilate, until vomiting occurs daily. The upper abdomen is distended between the attacks of vomiting. One patient stated that the distention of the abdomen resembled that of a six months pregnancy.

Anemia and weakness develop as do such toxic symptoms as lassitude, malaise and skin lesions. Urticaria that is constant and does not respond to treatment is sometimes present in these cases.

Cases of obstruction of the first portion present the same symptoms as those of pyloric obstruction. Jaundice and pain over the gallbladder may be present. Interference with the outflow of bile from the common duct due to excessive pressure within the duodenum or direct pressure of the dilated duodenum on the common duct may produce jaundice and clay colored stools. The distress is often aggravated when the patient is in the supine position. Sometimes the knee-chest position appears to afford relief as this facilitates the emptying of the dilated duodenum. There may be tenderness over the duodenum.

DIAGNOSIS

The symptoms of duodenal ileus are often misinterpreted, so that a correct diagnosis is not made until the duodenum is exposed during an exploratory operation. Even the roentgen ray may not clearly define the condition.

When patients with visceroptosis complain of the symptoms listed above the presence of duodenal ileus should be suspected. The vomiting of large amounts of bile stained fluid with evidence of retention, especially if associated with severe headaches, should arouse suspicion if other pathologic conditions can be ruled out. Barker lays stress on the examination of the vomitus for the presence of bile and pancreatic juices, as he states that the ducts empty into the duodenum and the presence of the juices in the vomitus would be evidence of regurgitation from the duodenum. As we know, the duct of Santorini opens above and in front of the common duct and the main pancreatic duct. Thus, if an obstruction lies between these two ducts there would be pancreatic ferments but no bile in the vomitus. The presence of pancreatic ferments is tested by fibrin digestion. The acid present in the fluid is neutralized and the fluid is then rendered slightly alkaline. A flake of fibrin stained with magenta red is then placed in the solution and incubated. If the fibrin is digested the fluid becomes red.

Hayes [51] suggests that the presence of tympany in an area behind the right rectus muscle and to the right or posterior to the pylorus between the transverse colon and liver indicates dilatation of the duodenum.

Zade [21] emphasized the value of the stomach tube for diagnosis as it makes it possible to differentiate between an hour glass stomach and a dilated duodenum in cases in which the symptoms suggest either of these conditions. His method is to compare the amount of water passed into the stomach through a stomach tube with the amount siphoned off, this procedure being followed by studying the tympanitic area on the abdomen. He found that in cases with pyloric relaxation and a dilated duodenum the pouch, which became filled with the residual water after the stomach was emptied, was well to the right of the midline.

The history and physical findings are important as has been shown by the fact that in a few of our cases a correct diagnosis was made before the roentgen-ray examination, but roentgen-ray and fluoroscopic examinations are of considerable value in many cases. Sometimes evidences of antiperistalsis with regurgitation of the barium meal into the stomach or of duodenal stasis may be secured by the fluoroscope, while

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51. Hayes, W. V.: A Few Signs Helpful in the Diagnosis and Management of Chronic Intestinal Stasis with Some Suggestions as to Treatment, Internat. J. Surg. **27**:134-136, 1914.

only a questionable roentgenogram is obtained. It should be realized that a pathologic condition may be present in the duodenum even if the duodenal cap fills perfectly. To eliminate duodenal stasis the duodenum should be observed at intervals for a period of from twenty to forty-five minutes. In many instances enteroptosis or gastroptosis render visualization of the third portion of the duodenum difficult and a lateral view must be taken to secure a good picture.

Obstruction of the second portion is more readily visualized as the dilatation is frequently above the transverse colon and is seen at the right of the stomach.

Delay in the passage of barium through the duodenum (duodenal stasis) is suggestive especially if the duodenum is constantly visible. Hayes' technic for visualization of the duodenum should be used in suspected cases.

Of course in all cases of acute dilatation of the stomach the condition should be suspected and an attempt should be made to see whether change of posture will relieve the symptoms.

TREATMENT

Many cases of arteriomesenteric ileus progress satisfactorily with nonoperative therapy. As has already been suggested, the knee-chest position may give relief; lying on the abdomen also relieves the mesenteric pull. Lying on the right side with the hips elevated tends to facilitate duodenal elimination and diminishes traction on the mesentery across the duodenum.

The knee-chest position should be assumed for fifteen minutes out of every two hours. Mechanically this relieves compression on the duodenum as the interior abdominal wall tends to bear the weight of the viscera. Duodenal lavage with the duodenal tube is of value. Carbohydrates should be prescribed and in general the diet should be of high caloric value and low in ferments. A corset should be applied (with the patient in the heel-shoulder position in cases of enteroptosis). Exercises for the strengthening of the abdominal wall should be insisted on.

If adequate medical treatment fails to alleviate the discomfort a duodenojejunostomy should be performed.

DUODENOJEJUNOSTOMY (CRILE TECHNIC)

In a duodenojejunostomy (Crile technic) the transverse mesocolon is exposed and the duodenum is exposed by an opening over its third part.

The anterior wall of the duodenum is picked up with Ally's clamps (care being taken that it is entirely free). The jejunum also is picked up with Ally's clamps, from approximately 7 to 10 cm. from the fossa

of Treitz. By the usual technic an anastomosis is made with a posterior row of interrupted silk sutures, after which the serosa and the mucosa are divided and approximated by means of the cobbler stitch with catgut. The anterior incision line is approximated in the same manner. Following this, interrupted silk sutures are inserted. The angle of the wound is carefully closed with interrupted silk sutures. The opening through the mesocolon is then attached behind the transverse colon above the line of anastomosis by means of interrupted silk sutures (Fig. 2).

This facilitates adequate elimination from the duodenum and the return of the duodenum to its normal condition provided the dilatation

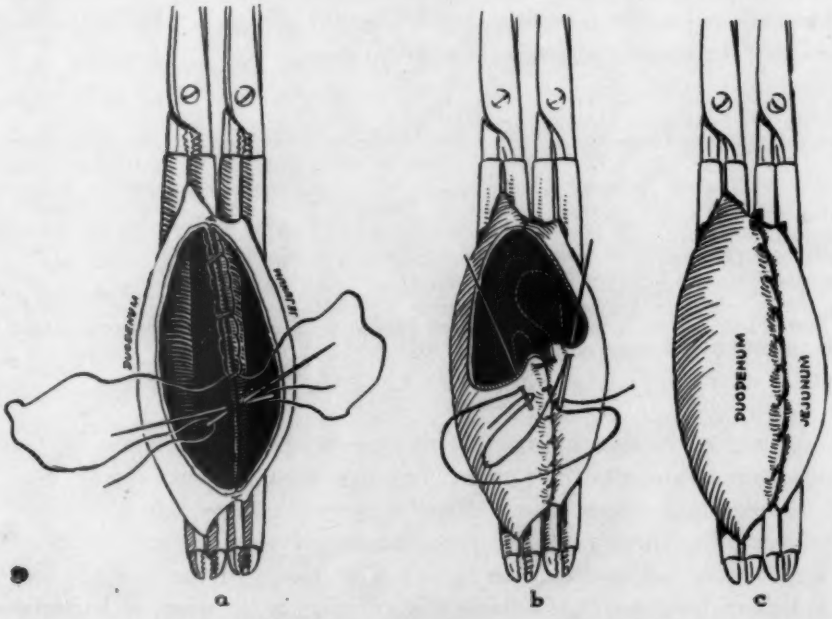

Fig. 2.—Duodenojejunostomy, Crile technic.

has not been present long enough for the duodenum to become atonic. In these cases the postoperative course is uneventful; there is practically no risk to the patient and the results are excellent.

From the mechanical point of view, it is easily understood why such satisfactory results are secured. The food is merely short circuited; elimination from the dilated duodenum is promoted; the bile and pancreatic juices are not interfered with, and digestion proceeds normally.

The cases that are associated with dilatation of the cecum and a mobile right colon present a different problem. Some men advise gastro-enterostomy, but the results are not satisfactory and a vicious circle may be established. It should be remembered that all the food

does not pass through the dilated pylorus and that therefore some stasis will be present in the dilated duodenum.

Other surgeons recommend resection of the right colon combined with an ileostomy which may be performed with safety in one stage. The end-results in these cases are also satisfactory.

In reviewing the opinion of various physicians and surgeons we find that duodenojejunostomy is favored by Barker, Bloodgood, Crile, Jones, Lower, Stavely, Tinkham, Vanderhoof and Wilkie, and that most surgeons agree that duodenojejunostomy is the method of choice if the obstruction is due to the mesentery. If the obstruction is due to adhesions they should be separated by sharp dissection, and if the duodenum is atonic a duodenojejunostomy also should be performed. If coloptosis is present resection may be deemed advisable. Robinson has reported three cures after gastro-enterostomy.

Results

Treatment	Number of Cases	No Improvement	Improved	Improved but Too Early for Conclusions	Complete Relief	No Report
Medical	31	2	19	2	1	7
Medical and surgical	3	..	1	..	2	..
Surgical	29	..	7	1	12	..

Three additional cases have been diagnosed; two of the patients are to return for operation; medical treatment was recommended for the third.

COMPLICATIONS

Wilkie states that ulcers may be associated with dilatation of the duodenum and reports three cases. I am reporting five such cases.

Kellogg and others believe that the stasis predisposes to ulceration. Codman cites Türck's studies of the effects of feeding food saturated with *Bacillus coli* to dogs. In twelve cases ulcers of the stomach and duodenum developed. He raises the question as to whether bacterial growth favored by stasis might not act similarly.

Cholecystitis or pancreatitis due to ascending infection along the ducts may occur.

MORTALITY

In our series there have been no deaths that could be directly attributed to surgical intervention. In one case in which miliary tuberculosis was found at operation, the patient died later from Addison's disease. In another case death was due to carcinoma of the sigmoid. The cases in which persistent vomiting necessitated surgical procedures progressed favorably.

In every case in which duodenojejunostomy was performed, except that of the patient who died of Addison's disease, complete relief was

obtained. In one case in which gastro-enterostomy was performed, periodical attacks of vomiting have continued so that a duodenojejunostomy will be performed later.

Thirty-four patients have been treated medically. In three cases among these the persistent vomiting necessitated an operation. Two patients were improved to such an extent that operation was not deemed necessary; in one case the symptoms were completely relieved. Seven patients have failed to answer the letter of inquiry regarding their present condition, and a few patients have improved, but sufficient time has not elapsed to warrant definite conclusions regarding their status.

CONCLUSIONS

Chronic duodenal ileus is not a rare condition and there are undoubtedly many cases that have not been diagnosed. On account of the severe headache associated with this condition a diagnosis of migraine is usually made; some patients have been treated for migraine for years and have passed through the clinics of excellent diagnosticians in a search for relief. In all cases of severe headache associated with vomiting a careful examination of the duodenum should always be made.

In cases in which the dilatation is insufficient to produce duodenal stasis and is associated with gastroptosis, an effort should be made to secure relief by nonoperative measures. If the dilatation is marked and stasis with antiperistalsis is present, a duodenojejunostomy should be performed. The mortality for duodenojejunostomy is practically nil and excellent results may be expected. Resection of the right colon is indicated in few cases and should be performed only as a last resort. Gastro-enterostomy should not be performed, as the stasis in the duodenum is not relieved and a vicious circle is established. A careful roentgen-ray examination of the duodenum should be made and a correct preoperative diagnosis established. A comprehensive history and a careful physical examination may suffice to make a correct diagnosis which, however, should be verified by roentgen ray. Dilatation of the duodenum is a clinical entity and a characteristic picture is present in most of the cases.

REPORT OF CASES

PATIENTS RECEIVING MEDICAL TREATMENT ONLY

CASE 1.—A woman, aged 24, came to the clinic because of pain in the stomach. For the preceding two years she had suffered from pain in the abdomen, which often occurred from three to four hours after meals. On account of the formation of gas she was unable to eat meats, acids or carbohydrates. The bowels were costive. At times during the night she would waken with a sensation of heaviness in the stomach.

The only important facts elicited by examination were the evidences of gastroptosis, anemia, and tenderness on deep pressure over the stomach below

the ensiform. Roentgen-ray examination showed marked stasis, with delay in the duodenum and reverse peristalsis. The stomach and duodenal cap filled normally.

The laboratory findings were: urine, normal; hemoglobin, 85 per cent.; red blood cells, 4,120,000; white blood cells, 6,400.

A diagnosis of dilatation of the duodenum was made. Medical treatment, consisting of a special corset, exercises, rest and diet, was instituted. Two months later the patient was having attacks of vomiting but she did not return for further treatment.

CASE 2.—A boy, aged 7 years, entered the hospital because of pain in the upper epigastrium. A history of pertussis and chickenpox was given. For the last few months the child had complained of pain in the epigastrium, occasionally quite severe. The temperature at times was from 99.2 to 99.4. The bowels were costive. Vomiting occurred during the acute attacks. For the preceding eight months he had been on a diet from which sugar, milk and fats were practically eliminated

The only significant points disclosed by the physical examination were that the boy was poorly nourished, pale and underdeveloped, with an abdomen of the visceroptotic type.

The laboratory findings were: urine, normal; hemoglobin, 70 per cent.; red blood cells, 4,130,000; white blood cells, 6,600.

The roentgen-ray examination revealed an incomplete obstruction at approximately the point where the superior mesenteric artery and mesentery crossed the spine. Above this point the duodenum was dilated and reverse peristalsis was present. A diagnosis of dilated duodenum was made.

The application of a binder and special diet were advised and improvement resulted.

CASE 3.—A woman, aged 56, entered the hospital because of attacks of stomach trouble. For twelve years the trouble had been more or less constant, the attacks increasing in severity and frequency. During the preceding five months she had lost 30 pounds (13.6 kg.). The attacks consisted of dull, nonradiating aching in the epigastrium. This came on a few minutes after meals and persisted until she vomited. Severe headaches accompanied the attacks. For a long time she had not eaten an evening meal so that she would avoid vomiting at night. Solid food aggravated the condition, fluids causing less discomfort. More recently she had had a sour stomach and heartburn. She had been on liquid diet for the preceding two weeks.

Examination disclosed an anemic, poorly nourished woman, with evidences of loss in weight. Tenderness was present over the entire abdomen, which was relaxed.

The laboratory findings were: urine, normal; hemoglobin, 70 per cent.; red blood cells, 3,990,000; white blood cells, 5,000; Wassermann reaction, negative. Gastric analysis revealed: free hydrochloric acid, 65; total, 79; lactic acid and bile were absent.

The roentgen-ray examination disclosed a dilated duodenum which retained barium after the stomach was empty.

Under medical treatment consisting of rest after meals, hyperacidity diet and postural exercises, some improvement resulted, but not complete relief of symptoms.

CASE 4.—A man, aged 36, entered the clinic complaining of stomach trouble. There was no point of interest in his personal history except a previous attack of influenza.

For the last three weeks he had had more or less constant abdominal discomfort. He stated that all the food he ate seemed to sour and to cause pain in the epigastrium; this was relieved by vomiting. The pain usually occurred from one to three hours after meals. The bowels were regular. There was tenderness to palpation in the epigastrium.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 4,780,000; white blood cells, 11,000; differential blood count, normal. Gastric analysis revealed: total acidity, 98; free acid, 64; bile, 3 plus.

The roentgen-ray examination showed that the first part of the duodenum was markedly dilated, and that it did not empty unless pressure was applied from above.

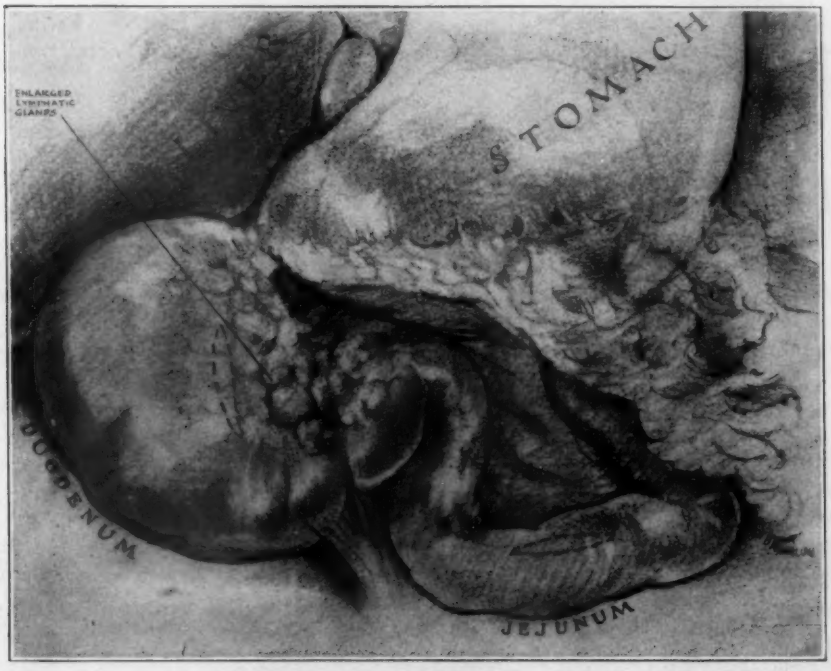

Fig. 3.—Duodenojejunostomy for megaduodenum in little girl, aged 5 years; broken lines represent points of approximation for the anastomosis.

Medical treatment, consisting of diet and postural exercises, was begun. Some improvement resulted, but the patient failed to report for later observation.

Case 5.—A man, aged 32, entered the clinic complaining of pain around the heart. He gave a history of a previous attack of typhoid. For the last two weeks he had experienced pain that came on suddenly when he stooped over to remove his shoes. Pain also occurred before and after meals. He was short of breath on exertion. His bowels were costive; his appetite was good; he was gaining in weight. Fulness in the upper part of the abdomen was present at irregular intervals.

Physical examination revealed a blood pressure of 100 systolic, 70 diastolic; slight exophthalmos with no enlargement or increased activity over the thyroid; a considerably relaxed abdominal wall. The heart and lungs were normal.

The laboratory findings were: Wassermann reaction, negative; urine normal; hemoglobin, 90 per cent.; red blood cells, 5,065,000; white blood cells, 3,600; blood sugar, 87 mg. per hundred cubic centimeters.

The roentgen-ray examination showed dilatation of the second and third portions of the duodenum and suggested the possibility of a duodenal diverticulum.

Operation was not considered justifiable and medical treatment, consisting of special diet and postural exercises was instituted. Five months later no dilatation could be discovered by the roentgen ray. The patient's condition continued to improve.

Case 6.—A man, aged 40, entered the clinic complaining of periodic attacks of vomiting. A past history of scarlet fever and rheumatism was elicited. Five years before he had begun to have bilious attacks about once a month. During the attacks, which lasted for from one to two weeks, vomiting occurred which was usually painless and lasted for from two to three days. Recently, he had had headaches over one eye. The bowels were costive.

Physical examination revealed a thin abdominal wall with visible outlines of some of the intestinal coils. The right kidney, cecum and descending colon were palpable.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent.; red blood cells, 4,230,000; white blood cells, 7,200; differential count, normal. Gastric analysis revealed: free acid, 15.5; total acid, 37.5.

The roentgen ray showed gastroptosis with atony. The duodenum and bulb were dilated; the cecum was mobile.

Medical treatment was instituted with some relief of symptoms, but no recent report has been received.

Case 7.—A woman, aged 27, entered the clinic complaining of nervousness, palpitation, and pressure in the stomach. The patient had been growing increasingly nervous for several years, especially during the last month. She experienced a sensation of fulness in the stomach after meals, with a feeling of weight and distention. There was nausea and regurgitation, but no vomiting. The bowels were costive. She had lost 20 pounds (9 kg.) in weight during the last year.

Physical examination disclosed a slender, undernourished female, asthenic in type. The thyroid was diffusely enlarged with increased activity at all poles. The abdomen was tender to palpation just above the umbilicus, and there were evidences of gastroptosis.

Laboratory investigation showed the urine and blood to be normal. The basal metabolic rate was plus 25.

The roentgen-ray examination indicated the presence of gastroptosis with atony and coloptosis, and showed a marked dilatation of the duodenum, together with a vigorously acting stomach; this suggested an intermittent obstruction of the duodenum by adhesions, probably from the gallbladder.

A thyroidectomy was performed by Dr. G. W. Crile and medical treatment for dilatation of the duodenum, diet, corset and postural exercises, was instituted. The patient's condition has improved.

Case 8.—A woman, aged 31, entered the clinic complaining of painful menstruation and severe headaches accompanied by nausea and vomiting. She had previously had typhoid and meningitis and a thyroidectomy had been performed. The patient had always been subject to headaches. During the last ten years she had suffered from severe pain, localized to the right of the mastoid bone.

She was occasionally nauseated and sometimes vomited. She dated the onset of the headaches from an attack of cerebral meningitis fifteen years before, at which time she was confined to her bed with fever, stiff neck and attacks of unconsciousness. The pain had become more severe during the last few years, and was worse during the menses.

A diagnosis of migraine and of neuralgia of the great occipital nerves had previously been made, and an injection of the sphenopalatine ganglion had been performed.

The physical examination failed to elicit any important points. The gastric analysis revealed: total acid, 85; free acid, 32.5. Other laboratory findings were normal.

A roentgenogram was taken which showed a mobile, dilated pelvic cecum, and dilatation of the second and third portions of the duodenum.

A diagnosis of dilatation of the duodenum was made and medical treatment —corset, diet, postural exercises, diluted hydrochlorid acid and iron—was instituted. The condition of the patient improved, but too short a period of time has elapsed to warrant definite conclusions.

CASE 9.—A woman, aged 32, entered the clinic complaining of stomach trouble. A thyroidectomy had been performed in 1908, a nephrectomy in 1916, an appendectomy in 1921. For several years the patient had had a dull, aching pain in the upper part of the abdomen which was not associated with vomiting, though she had some nausea. She had frequent headaches which were accompanied by gastric disturbances. The bowels were costive. After the thyroidectomy the patient had developed tetany, which has persisted in spite of treatment.

Physical examination elicited tenderness and spasm on pressure over McBurney's point.

The laboratory findings were: blood and urine, normal; Wassermann reaction, negative.

The roentgen ray showed the second and third portions of the duodenum to be considerably dilated.

A diagnosis of dilatation of the duodenum was made and medical treatment was instituted, as the result of which the patient reports that most of her abdominal discomfort has been relieved.

CASE 10.—A man, aged 62, entered the clinic complaining of headaches and bilious attacks. His father had died of an aneurysm. The onset of the bilious attacks dated back ten years, and the headaches had occurred even previous to that time. The attacks began with severe headaches and sour stomach, which were relieved by soda or copious emesis; diarrhea occurred during the attacks. The bowels were fairly regular. He formerly belched considerably.

Physical examination revealed an asthenic type of man. The left colon was palpable, and the stomach was palpable below the umbilicus.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 3,980,000; white blood cells, 5,300.

The roentgen ray showed a dilated duodenal bulb and an elongated and moderately enlarged duodenum, with stasis; ptosis of the cecum also was present.

A diagnosis of dilatation of the duodenum was made and medical treatment was instituted. The period of time that has elapsed since treatment was started is insufficient to warrant definite conclusions.

CASE 11.—A woman, aged 21, entered the clinic complaining of a goiter and of stomach trouble. She had previously been operated on for appendiceal abscess and had had a dilatation and curettage. The illness of which she

complained at this time had begun a year before with nervousness, palpitation, loss of weight and tremor. She was subject to epigastric pain and right-sided headache which usually came on about noon. These symptoms were relieved by vomiting. The vomitus was yellowish brown and often contained food particles.

Examination showed that she had a bilateral enlargement of the thyroid, with a small adenoma on the right; also tenderness with spasm in the outer upper quadrants of the abdomen, most marked on the left.

Laboratory examination showed the blood and urine to be normal.

Roentgen-ray examination disclosed a duodenal dilatation with stasis, and a mobile, slightly ptosed cecum. A diagnosis of dilatation of the duodenum was made, and medical treatment was instituted with resultant improvement.

CASE 12.—A man, aged 45, entered the clinic complaining of stomach and bladder trouble. He had had an appendectomy twenty-two years before, and a cystostomy seventeen years before. He had had "bloating" of the stomach for years, the discomfort arising immediately after each meal and lasting for approximately one hour. At this time he had nocturia once each night. He was quite constipated, was nervous and at any new shock experienced a "gripping" of the stomach. His weight was stationary.

Physical examination revealed evidence of gastroptosis and spasticity of the transverse and descending colon.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 4,120,000; white blood cells, 5,800; differential count, normal.

Roentgen-ray examination showed the stomach to be normal; marked hypermobility of the duodenal bulb, which was dilated; dilatation of the second and third parts of the duodenum, and a small stone in the lower part of the left ureter.

A diagnosis of dilatation of the duodenum and of left ureteral calculi was made, and medical treatment was instituted. No report has been received from this patient.

CASE 13.—A woman, aged 48, entered the clinic because of headaches. For some time she had had headaches which were periodic in type, and usually were one-sided, occurring over one eye or the other. She was nauseated during the attack but did not vomit. The bowels were costive.

Physical examination revealed an undernourished patient with evidences of gastroptosis.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 3,860,000; white blood cells, 4,700; blood sugar, 103 mg. per hundred cubic centimeters.

Fluoroscopic examination showed dilatation of the second and third portions of the duodenum; and the roentgen ray also showed an irregular constriction of the bulb which suggested the presence of adhesions to the gallbladder or liver. The lower pole of the stomach was just above the pubis.

A diagnosis of dilatation of the duodenum was made, and medical treatment, with diet, postural exercises and a corset, was begun, as the result of which the patient has improved slowly.

CASE 14.—A woman, aged 34, entered the clinic complaining of headache. There was a past history of scarlatina, pleurisy, and of an operation in which the tip of the coccyx had been removed. For two years the patient had had attacks of severe headache every month or so, with vomiting and a distressed feeling in the right side of the upper part of the abdomen. Between the

attacks there had been only slight abdominal pain. During the headaches she would vomit for one or two days. The bowels were costive; the appetite was good, the weight, stationary.

Examination revealed a tall, slim woman who appeared to be in poor health. The abdomen had a normal contour. The lower poles of both kidneys were palpable. A succussion splash was present over the stomach; there was a slight muscle spasm over the gallbladder, but no definite tenderness; a spastic sigmoid was palpable.

The laboratory findings were: urine, normal; Wassermann reaction, negative; blood, normal.

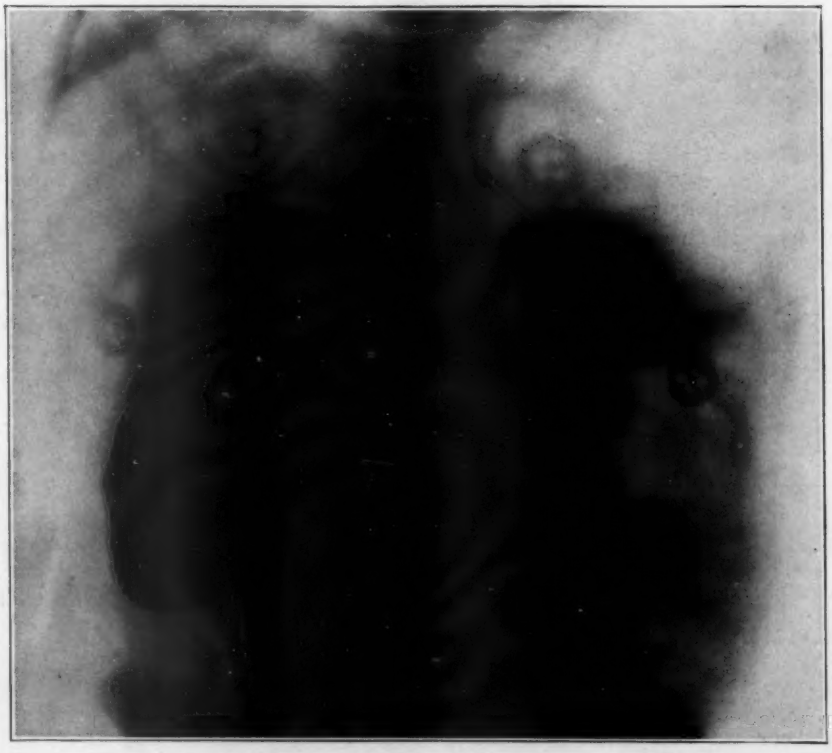

Fig. 4.—Megaduodenum (same case as shown in Figure 3).

The roentgen ray revealed a ptosed stomach, a normal duodenal bulb and an irregularly constricted and dilated duodenum with duodenal stasis.

For two years this patient has been under medical treatment for migraine, visceroptosis and chronic intestinal stasis with little improvement. This appears to be a classical case of duodenal dilatation, and I believe that complete relief of the headache, vomiting and pain would follow duodenojejunostomy.

Case 15.—A man, aged 40, entered the hospital complaining of stomach trouble. He had had diphtheria when a child. For two years he had had intermittent attacks of stomach trouble, which were characterized by a burning sensation in the pit of the stomach associated with bloating from gas in the stomach and intestines; this occurred from two to four hours after meals

and occasionally at night. It was relieved by baking soda and food. He had had a skin eruption for months.

Examination revealed slight tenderness over the appendix and vague sensitiveness over the duodenal region.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 4,250,000; white blood cells, 8,700.

The roentgen ray showed a characteristic ulcer deformity (duodenal) with considerable dilatation of the descending duodenum.

The patient was placed on the medical regimen for duodenal ulcer. Four months later he was considerably improved and less deformity of the duodenal cap was present.

CASE 16.—A woman, aged 24, entered the clinic complaining of pain in the stomach, which she had experienced for two years. She had vague stomach symptoms, and was unable to eat anything with comfort on account of the formation of gas in the stomach. She had had influenza two years previously; her weight was stationary; there was no vomiting.

Physical examination showed nothing of significance except tenderness on deep pressure over the stomach.

The laboratory findings were normal.

The roentgen ray showed that the stomach and duodenal cap were normal, but there was marked ptosis with delay in the duodenum and reverse peristalsis.

Operation was advised but the patient wished medical treatment. She returned two years later complaining of an increase in the stomach symptoms, of occasional vomiting and of headaches. There had been no gain in weight; the bowels were regular. A strict medical regimen was again instituted with some resultant improvement.

CASE 17.—A man, aged 50, came to the clinic because of attacks of anorexia, nausea, epigastric distress and vomiting. There was a past history of syphilitic lesions and of a gonorrheal infection twenty-five years before, also of malaria and pleurisy. A cholecystectomy and appendectomy had been performed three years before. About fourteen years before he developed attacks of indigestion, which at first were severe and occurred at intervals; but for the last eight weeks he had had continuous epigastric distress with nausea and vomiting. No gallstone had been found at the previous operation, although a diagnosis of cholelithiasis had been made. He was losing weight and becoming weak, and had occasional attacks of transient vertigo. He was markedly constipated.

Examination revealed an emaciated, elderly man appearing worried and weak. A systolic murmur was present at the apex and transmitted to the axilla. The abdomen was scaphoid.

The laboratory findings were: urine, normal; Wassermann reaction, 4 plus; the colloidal gold test showed a tabetic curve; the blood picture was normal. Gastric analysis revealed: free acid, 1.5, total acid, 21.5.

Roentgen-ray examination showed dilatation of the duodenum with a deformity at the pyloric end of the stomach which was probably due to adhesions.

A diagnosis of tabetic crisis and dilatation of duodenum was made. Antisyphilitic treatment was advised and a special diet, with the addition of hydrochloric acid.

CASE 18.—A man, aged 37, entered the clinic complaining of stomach trouble and headaches. An appendectomy had been performed four years

before. Headaches and stomach trouble began about fifteen years before, usually occurring when the patient was constipated. When the bowels had not moved for a day or two he would get dizzy and feel a thumping in the head; this terminated in a severe frontal headache which was not relieved until copious emesis had occurred. The vomitus at first consisted of food, but it continued after the stomach seemed to be empty, the later vomitus consisting of watery, bitter, green fluid. The attacks of vomiting lasted for from four to five hours. About an hour later the headache would begin to subside. The bowels were very costive. He had no abdominal pain, except occasional cramps.

Physical examination revealed a man of fairly healthy appearance. The abdomen was not distended, but there was generalized tenderness over the colon.

Laboratory findings were normal.

A roentgen-ray examination revealed dilatation of the duodenum, which was marked at the knee of the duodenum; there was a large diverticulum which held the barium twenty-four hours, and a deformity, evidently due to duodenal ulcer. The colon was generally spastic.

A diagnosis of duodenal ulcer, duodenal dilatation and diverticulum was made and medical treatment for the ulcer was instituted. An insufficient period of time has passed for any conclusions regarding the result.

CASE 19.—A woman, aged 29, entered the clinic complaining of hives. She had had an appendectomy twelve years before. The present trouble dated back two years when hives had appeared around the face and body. Later she had experienced considerable itching, and hives with welts appeared and have continued at intervals ever since. She had had frequent sick headaches with attacks of vomiting. The bowels were costive.

Examination was essentially negative except for the skin lesions and an infantile uterus.

The laboratory findings were: urine, normal; Wassermann reaction negative; hemoglobin, 85 per cent.; red blood cells, 4,550,000; white blood cells, 8,500; differential count, normal; blood sugar, 91 mg. per hundred cubic centimeters; blood urea, 39; blood uric acid, 2.2; serum calcium, 13.

The roentgen ray revealed dilatation of the second and third portions of the duodenum with high fixation of the bulb.

A diagnosis of urticaria, dilated duodenum and infantile uterus was made, and medical treatment was instituted with some resultant relief.

CASE 20.—A woman, aged 49, entered the clinic complaining of stomach trouble and headaches. She had had typhoid fever at the age of 13. One year before the patient had had influenza. She complained of burning pain in the right side of the upper part of the abdomen and in the pit of stomach associated with nausea and vomiting. She was short of breath on exertion. The abdominal pain did not radiate. She had always been subject to sick headaches; her appetite was poor, and at this time she was on a diet. The bowels were very costive.

Examination revealed a thin woman, evidently in poor health; the abdomen was lax and doughy.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent.; red blood cells, 4,660,000; white blood cells, 9,000.

Roentgen-ray examination showed dilatation of the second and third parts of the duodenum with temporary stasis.

Medical treatment was instituted with resultant improvement.

CASE 21.—A woman, aged 47, entered the clinic complaining of biliousness and liver trouble. She had had nausea and belching for years, and was usually constipated. One and one-half years and six months before she had had severe attacks of pain in the epigastrium and radiating to the back with very severe vomiting of bile stained fluid. Between these attacks she had considerable gas and nausea. The stools were light colored during the attacks. She had frequent headaches.

Physical examination revealed nothing of significance except for tenderness in the region of the gallbladder with the production of pain.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 4,130,000; white blood cells, 7,500.

The roentgen ray revealed dilatation of the duodenum, right-sided ptosis and dilated pelvic cecum. There was no evidence of any pathologic condition in the gallbladder.

Medical treatment for dilatation of the duodenum was instituted.

CASE 22.—A woman, aged 49, entered the clinic because of diabetes. She had previously had malaria. Diabetes was discovered one and one-half years before. Sugar did not appear in the urine after the patient was placed on a diet. She reentered the clinic because of the occurrence of pain in the stomach soon after eating, with palpitation and dyspnea. The stomach trouble began two weeks before. The bowels were costive.

Examination revealed a thin, sallow woman with a blood pressure of 110 systolic, 60 diastolic, and a definite, palpable thickening of the arteries. Tenderness was present in the region of the pylorus.

The laboratory findings were of little significance except for a blood sugar of 191 mg. per hundred cubic centimeters.

Roentgen-ray examination showed duodenal dilatation and kinking at the jejunal junction, which was evidently due to adhesions. The stomach and duodenal bulb were normal.

The patient was placed again under medical treatment for diabetes and treatment for dilatation of the duodenum was instituted with some resultant relief.

CASE 23.—A man, aged 40, entered the clinic complaining of stomach trouble. For some time he had felt nauseated in the mornings. He would feel better for an hour after breakfast, then would be distressed until noon, with relief again for an hour after the meal. He complained of considerable gas, but no vomiting. The bowels were very costive.

Examination showed the patient to be undernourished. His blood pressure was 120 systolic, 80 diastolic. There was slight abdominal tenderness.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 4,590,000; white blood cells, 7,900. Gastric analysis revealed: free acid, 7; total acid, 28.

Roentgen-ray examination showed a normal stomach and duodenal bulb, but antiperistalsis in the second and third parts of the duodenum. A diagnosis of chronic intestinal stasis with dilatation of the duodenum was made, and medical treatment was instituted with resultant improvement.

CASE 24.—A woman, aged 30, came into the clinic complaining of stomach trouble and skin lesions. An appendectomy had been performed two years before. She had always had stomach trouble, the worst feature of which was the persistent, almost constant daily vomiting of her meals. She had marked heartburn. For two years she had had pain in the epigastrium from two

to four hours after meals. The pain did not radiate. She would be awakened at night by the gastric distress. There had been no change in weight.

Examination revealed a healthy looking woman with a blood pressure of 105 systolic, 60 diastolic. There was generalized slight tenderness over the abdomen.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 4,290,000; white blood cells, 4,400.

Roentgen-ray examination revealed dilatation of the second and third portions of the duodenum; the stomach and bulb were normal.

A diagnosis of dilatation of the duodenum and possible gastric ulcer was made. Medical treatment was given with resultant improvement of the condition.

Fig. 5.—Dilatation of duodenum due to adhesions at duodenojejunal junction resulting from inflammatory mesenteric glands.

CASE 25.—A man, aged 43, entered the hospital complaining of stomach trouble. There was a past history of typhoid, malaria and pneumonia. He had had more or less stomach trouble for twenty years, consisting of bilious attacks with headaches and vomiting. His bowels were habitually constipated; the stools were pencil-like. When food was not taken he experienced a burning sensation in the epigastrium which was relieved by food or water. There had been no loss in weight.

Examination revealed a well developed man with sallow skin. The blood pressure was 106 systolic, 80 diastolic. The abdomen was rounded. There was tenderness below the left costal margin, and pressure over McBurney's

point produced pain referred to the former region. The sigmoid and descending colon were spastic.

The laboratory findings were: Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 4,670,000; white blood cells, 6,300.

The roentgen ray revealed a moderate dilatation of the second and third portions of the duodenum suggesting duodenal stasis; the cecum was mobile; the appendix was not visualized.

Medical treatment for dilatation of the duodenum and constipation was instituted.

CASE 26.—A man, aged 25, entered the hospital complaining of pain and burning in the epigastrium. Four years before he had had deep jaundice, which was soon followed by pain in the upper abdomen. There had been no nausea or vomiting. His stools were clay colored. He had lost 10 pounds (4.5 kg.) in weight. He had had a slight jaundice for two years but this had entirely disappeared. Five weeks before he had developed a pain in the lower abdomen just below and to the right of the umbilicus. This shifted to the upper part of the abdomen and a sensation of burning not related to meals remained in the epigastrium. Soda seemed to give some relief. He sometimes had headaches.

Examination revealed a thin, apprehensive man of asthenic type, with a scaphoid abdomen and slight tenderness over the right side of the upper part of the abdomen.

The laboratory findings were: urine, normal; Wassermann reaction, negative; blood picture, normal.

The roentgen ray revealed a marked churning movement in the duodenum, which was slightly dilated. At times the barium was carried back into the bulb and stomach.

A diagnosis of dilatation of the duodenum was made and medical treatment was instituted.

CASE 27.—A woman, aged 24, entered the clinic complaining of pain in the lower part of the abdomen and of weakness with "dizzy spells." She had developed these symptoms since a miscarriage one year before. She was very weak and frequently obliged to go to bed. The pain at first had been in both sides but at this time was in the right side of the lower part of the abdomen. It had been worse during the preceding few days. She had a slight nausea, and was troubled with sour stomach and gas.

Examination revealed a fairly well nourished woman, with a blood pressure of 116 systolic, 70 diastolic. The right kidney was palpable. There was some gurgling in the region of the cecum and tenderness in the right lower quadrant. Vaginal examination revealed tenderness in the right adnexal region.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 75 per cent.; red blood cells, 4,010,000; white blood cells, 9,500.

Roentgen-ray examination showed a moderate dilatation of the duodenum with reverse peristalsis, and ptosis of the stomach.

A diagnosis of dilatation of the duodenum and salpingitis was made; medical treatment was instituted with resultant relief of the symptoms.

CASE 28.—A woman, aged 29, entered the clinic complaining of stomach trouble. She had had a previous appendectomy and an attack of influenza one year before, and since had had attacks of sour stomach and vomiting. She also was troubled with gas and belching. Her appetite was good. The bowels were costive.

Examination revealed a slight young woman with a blood pressure of 115 systolic, 75 diastolic. The abdomen was distended with gas.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent.; red blood cells, 4,180,000; white blood cells, 7,600.

Roentgen-ray examination revealed distortion and dilatation of the descending duodenum and a distended colon.

Medical treatment was instituted with resultant improvement.

CASE 29.—A woman, aged 46, entered the clinic complaining of nausea. She gave a past history of bilious attacks for which cholecystectomy had been performed. She also had had an appendectomy and a right oophorectomy. She had had daily attacks of nausea for some years, starting each spring and lasting all summer. The nausea was present when she woke in the morning and tended to clear up by night. There was not much pain but some discomfort under the right scapula. She ate practically no food. The bowels were costive so that she took an enema every day. She had occasional headaches.

Examination revealed a short, obese woman with a blood pressure of 98 systolic, 70 diastolic. The liver edge was palpable.

The laboratory findings were: urine, normal; hemoglobin, 85 per cent.; red blood cells, 4,610,000; white blood cells, 9,200. Gastric analysis revealed: free acid, 0; total acid, 16.

The roentgen ray revealed that the descending duodenum was considerably elongated and that there was some stasis. A diagnosis of dilatation of the duodenum was made and medical treatment was instituted.

CASE 30.—A girl, aged 15 years, entered the hospital complaining of nausea, vomiting, weakness and loss of weight; she also had tachycardia. There was a past history of influenza. The patient had been in good health until one month before when she felt ill and began to vomit in the morning. Since that time she had had periods of nausea and vomiting. The vomitus was sour and consisted of the previous meal. She complained of weakness and had lost 16 pounds (7.3 kg.) in the preceding month. She had been given Lugol's solution with no resultant improvement.

Examination revealed a diffuse bilateral enlargement of the thyroid, but otherwise nothing of importance.

The laboratory findings were: urine, normal; hemoglobin, 85 per cent.; red blood cells, 4,710,000; white blood cells, 9,200; basal metabolism, plus 15. Gastric analysis revealed: free acid, 0; total acid, 25.

The roentgen ray showed a dilatation of the entire duodenum, and duodenal stasis was observed fluoroscopically. The stomach and duodenal bulb were normal. There was a moderate general resistance of the colon.

The patient was placed under medical treatment. The vomiting ceased while the patient was in the hospital and she was discharged. Two weeks later the father stated that she had had vomiting spells for two days, during each of which she would vomit five or six times. The vomiting was associated with a unilateral headache. This patient is to return later for a duodenojejunostomy.

CASE 31.—A woman, aged 34, entered the clinic complaining of constipation and attacks of vomiting. She had been constipated for fifteen years. For the last four years she had had recurrent attacks of vomiting a few weeks apart. These attacks occurred when the bowels were sluggish. Early in the attacks she would get nauseated, and would finally vomit many times for days. She was losing in weight and had frequent headaches.

On examination the patient was found to be a small, slight woman with a blood pressure of 110 systolic, 60 diastolic. Slight tenderness was present over the cecum; spastic intestinal coils could be felt.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent.; red blood cells, 4,520,000; white blood cells, 7,800; calcium, 8.

Roentgen-ray examination showed a moderately dilated but normal duodenal bulb held high in the right side of the hypochondrium. It was difficult under the fluoroscope to force barium from the bulb into the descending duodenum. The colon was atonic.

Diagnosis of gastric tetany and dilatation of the duodenum was made. Medical treatment was instituted and operation advised if relief was not secured.

CASE 32.—A woman, aged 27, in whom a diagnosis of globus hystericus had previously been made, returned to the clinic two years later complaining of frontal and temporal headache which was sharp and throbbing in character and was worse on exertion. She had no vomiting, but vertigo was usually associated with the headaches which were quite severe at times and necessitated immediate rest. These attacks were gradually getting worse.

Examination revealed a well developed and nourished woman, with a slightly enlarged thyroid gland but no increased activity.

The laboratory findings were normal.

Roentgen-ray examination revealed an undoubted moderate duodenal dilatation and duodenal stasis.

A diagnosis of dilatation of the duodenum was made. Medical treatment was recommended.

PATIENTS RECEIVING MEDICAL AND SURGICAL TREATMENT

CASE 33.—A woman, aged 21, entered Lakeside Hospital because of nausea and pain in the abdomen with vomiting and headaches.

Following an appendectomy four months previously she had gained 10 pounds (4.5 kg.) in weight; but the distress returned and she had pain 3 cm. above the umbilicus to both the left and the right of the midline. This occurred every day or so, soon after meals, especially after she had eaten a considerable amount. The pain lasted from one-half to one hour; there had been no vomiting recently but the nausea was persistent. She had previously vomited every morning soon after rising; the vomiting relieved the severe headaches that accompanied the attacks. Pain radiating to the left shoulder and back occurred occasionally at night. This was stabbing or cramping in character.

The only fact elicited by examination was a sharply defined area of tenderness the size of a dollar, 2 cm. above and to the left of the umbilicus, with some tenderness also in the right upper quadrant. The blood and urine were normal.

Roentgen-ray examination showed apparently delayed emptying of the duodenum with dilatation of the second portion. The fluoroscopic examination showed dilatation of the duodenum with incomplete and temporary obstruction of the third portion.

Medical therapy, consisting of a corset, postural exercises and diet, was instituted for six months. The symptoms were somewhat relieved but vomiting persisted. A duodenojejunostomy was performed by Dr. Crile, at which the duodenum was found to be markedly dilated proximal to the point where it passed under the mesentery. Complete relief of symptoms has resulted.

CASE 34.—A man, aged 41, entered the clinic complaining of headaches and nausea. An appendectomy had been performed two years before, after which the same symptoms recurred. Pain referred to the shoulder-blades and accompanied by a sensation of fulness was present chiefly in the upper epigastrium. The bowels were costive. There was occasional nausea associated with severe headaches. The patient had lost 10 pounds (4.5 kg.) in the preceding four years.

Examination revealed an asthenic man with evidences of visceroptosis.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent; red blood cells, 4,240,000; white blood cells, 6,100; Wassermann reaction, negative. Gastric analysis revealed: free acid, 38; total, 57.5; no bile or lactic acid.

Fig. 6.—Dilatation of duodenum due to adhesions caused by penetrating ulcer of lower curvature.

Roentgen-ray examination showed the stomach and duodenal bulb to be normal, but there was a large pouch just beyond the bulb.

A diagnosis of dilatation of the duodenum was made.

Medical treatment, consisting of a corset, postural exercises and diet, was instituted for one month with no relief.

An operation was then performed by Dr. G. W. Crile, at which the duodenum was found to be markedly dilated as the result of obstruction at the point where it crossed under the mesentery, which was very heavy; beyond this point no dilatation was seen.

A duodenojejunostomy was performed resulting in complete relief of symptoms.

CASE 35.—A woman, aged 47, entered the clinic complaining of constipation, headaches and vomiting. She had been constipated for years. She suffered from abdominal distress after meals and every two or three days had attacks of severe headache and nausea which were relieved by vomiting; she had frequent attacks of faintness. Her appetite was good but she was losing in weight.

The only points of importance elicited by the physical examination were that the patient was poorly nourished and pale; there was twitching of the upper and lower eyelids and a systolic murmur at the apex transmitted to the axilla, and there was some evidence of visceroptosis.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 4,308,000; white blood cells, 5,500.

Treatment by a support, postural exercises and a special diet was tried but the symptoms were not relieved and a later roentgen-ray examination showed that the cecum and ascending colon were very mobile, the hepatic flexure being at the level of the iliac crest.

At operation, which was performed by Dr. W. E. Lower, the last part of the first and second and third parts of the duodenum were found to be dilated to three times their normal size, owing to an obstruction at the point where the duodenum passed under the mesentery.

A gastro-enterostomy was performed, but only temporary improvement resulted and the patient will return for another operation.

PATIENTS RECEIVING SURGICAL TREATMENT ONLY

CASE 36.—A woman, aged 40, entered the hospital complaining of constipation and pain in the left upper portion of the abdomen.

Six years before she had suffered from an attack of acute indigestion and pain in the back which extended around to the heart. This pain was intermittent at first but had been more or less constant for the preceding four years. The bowels were costive; the appetite was poor, and regulation of the food was ineffectual. She had lost 10 pounds (4.5 kg.) in four years.

The blood and urine were normal and the Wassermann reaction was negative.

On examination diastasis of the recti muscles was marked. The lower pole of the right kidney was palpable and the entire kidney movable.

A diagnosis of chronic appendicitis was made, but at the operation, which was performed by Dr. G. W. Crile, the duodenum was found to be markedly dilated and ptosis of the stomach also was present. The duodenum passed under the mesentery, which was tight, and its vessels were dilated. A duodenojejunostomy and appendectomy were performed.

Four years later the patient reported that she had remained entirely well.

CASE 37.—A woman, aged 38, entered Lakeside Hospital complaining of attacks of pain in the epigastrium which were accompanied by severe headaches. For months she had been feeling unwell.

The only significant facts in the personal history were that she had had typhoid fever some years before, that her bowels were constipated, and that her weight was stationary.

The only findings of importance in the physical examination were enlargement of the thyroid, visceroptosis and a palpable right kidney.

The laboratory findings were normal. Roentgen-ray examination showed gastroptosis and evidence of stasis in the duodenum which did not empty well.

A diagnosis of dilatation of the duodenum was made and an operation was performed by Dr. G. W. Crile, which confirmed the roentgen-ray findings of gastroptosis and disclosed a greatly dilated duodenum with obstruction where the root of the mesentery crossed the duodenum.

Duodenojejunostomy and appendectomy relieved all the symptoms.

CASE 38.—A woman, aged 44, entered the clinic complaining of headache, weakness and vomiting. In the personal history the only point of interest was that she had had diphtheria. The present distress had first been noticed six months before. The attacks of vomiting had recently increased in frequency. Two months before she had fainted, and weakness had progressively increased. The headaches were severe but were relieved by the vomiting that occurred about one hour after meals. One month before she had experienced pain in the midepigastrium but this had subsided recently. She had been under medical treatment for the preceding six months.

Physical examination disclosed an anemic, poorly nourished woman. There were a few moist râles in the left apex of the lungs. The colon was palpable.

The laboratory findings showed albumin present in the urine; hemoglobin, 75 per cent.; red blood cells, 3,800,000; white blood cells, 5,400; differential count, normal; Wassermann reaction, negative. Gastric analysis revealed: free, hydrochloric acid, 50; total acidity, 82.

Roentgen-ray examination revealed a normal stomach, but the first portion of the duodenum was held toward the right suggesting the presence of adhesions. A diagnosis of dilatation of the duodenum was made.

At operation, which was performed by Dr. G. W. Crile, the duodenum was found to be dilated to two or three times its normal size from the pyloric end of the stomach to the point where it passed under the mesentery. The walls of the duodenum appeared to be atonic. Beyond the mesentery the intestines appeared normal.

A duodenojejunostomy was performed resulting in complete relief of symptoms.

CASE 39.—A woman, aged 55, entered the clinic complaining of pain in the epigastrium. About one year before pain had developed in the region of the gallbladder. The pain was intermittent, occurring at intervals of from two to three hours after meals. The temperature was sometimes elevated. Constipation was quite marked. The appetite was poor and there had been considerable loss of weight.

Physical examination revealed a thin, poorly nourished woman of sallow complexion. The abdomen was extremely flat and both kidneys were palpable.

The laboratory findings showed a secondary anemia.

An exploratory operation by Dr. G. W. Crile revealed a greatly dilated duodenum with a tight mesentery and adhesions about the gallbladder. The patient's condition became unfavorable during the operation and therefore the operation was limited to a narrowing of the lumen of the duodenum with silk sutures. One year later the patient was free from her former discomfort, but she complained of distention of the abdomen and of increasing constipation. Examination revealed a mass in the sigmoid flexure of the colon, which the operation showed to be an extensive carcinoma. In this case the original disturbance caused by the dilated duodenum was relieved by the plastic operation on the duodenum.

CASE 40.—A woman, aged 57, entered the clinic complaining of pain in the abdomen and vomiting. For the preceding three or four weeks the patient had had attacks of vomiting. The gallbladder, which was adherent to the duodenum

and contained stones, was removed. The second and third portions of the duodenum were found to be enormously dilated, and the question arose as to whether or not this was the cause of the vomiting. The patient was comfortable for two days following the operation and then began to vomit again. The vomiting, which was unaccompanied by pain, occurred at intervals of one or two days. By binding the abdomen and forcing the intestines upward, the vomiting seemed to be prevented and the patient was discharged from the hospital but was told to return if the vomiting recurred. Two months later she returned with a history of almost continuous vomiting for the preceding week with considerable loss of weight and strength.

Fluoroscopic examination showed the stomach in a low position, extending to the anterior superior spine. Bismuth passed into the duodenum where it stopped at the midline, ballooning out the duodenum to two or three times its normal size and then regurgitating back into the stomach. The roentgen-ray showed two fluid levels, one in the stomach and one in the duodenum in the obstructed third portion.

At operation, which was performed by Dr. H. G. Sloan, miliary tuberculosis was found to be present and also an enormous dilatation of the duodenum, which seemed to be compressed between the root of the mesentery and the spinal column. A duodenojejunostomy was performed. No vomiting followed the operation but four months later the patient died of Addison's disease.

Case 41.—A man, aged 41, entered the clinic complaining of a dull pain across the back, violent headaches and a sensation of burning in the upper part of the abdomen. He had had a previous appendectomy. The foregoing symptoms had been present for ten years. At first they occurred every two or three months lasting from four to six hours, until he vomited greenish yellow, bitter fluid. When he had vomited, the headaches would subside, but the pain in the back and the tenderness under the right costal margin would persist for two or three days. Recently the attacks had become more frequent. The bowels were costive.

Physical examination revealed at the apex a systolic murmur which was transmitted to the axilla. Over the gallbladder there was slight tenderness to deep palpation.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 3,997,000; white blood cells, 11,400; differential count, normal.

Roentgen-ray examination showed that the stomach and duodenal bulb were filled normally; but the fluoroscopic examination gave evidence of a moderate dilatation of the second and third portions of the duodenum.

At operation, which was performed by Dr. G. W. Crile, the pyloric ring was found to be dilated as were also the first and second parts of the duodenum, to the beginning of the third portion. The obstruction was produced by the mesentery as it passed over the third portion of the duodenum. A duodenojejunostomy was performed, and was followed by the complete disappearance of the symptoms.

Case 42.—A woman, aged 28, entered the clinic complaining of pain in the abdomen. In 1918, seven years before, a gastro-enterostomy had been done for gastric ulcer; a plastic operation on the gastro-enterostomy for relief of obstruction was performed four years later, and a laporatomy for adhesions seven months after the plastic operation. During the seven years since the first operation the patient had had attacks of generalized abdominal distress, with severe headaches and vomiting, after taking solid foods or acids. Her

weight had been stationary, but her appearance was that of a poorly developed and undernourished woman.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 70 per cent.; red blood cells, 3,100,000; white blood cells, 7,800.

Roentgen-ray examination showed no barium passing through the gastro-enterostomy stoma. The second and third portions of the duodenum were dilated, and the lower pole of the stomach was at the level of the iliac crests.

At the exploratory operation performed by Dr. W. E. Lower, dense adhesions were found between the coils of intestines; the gastro-enterostomy

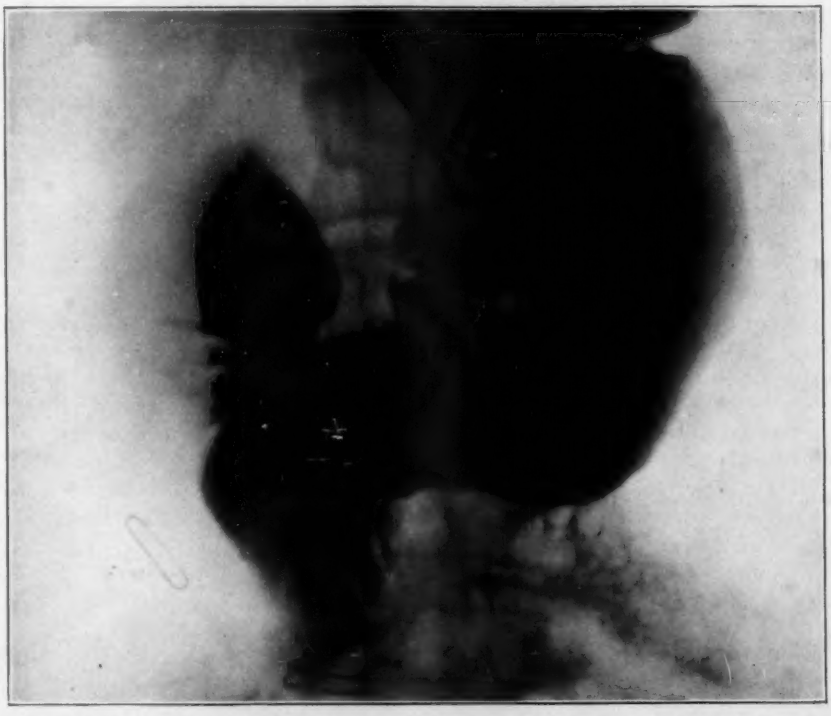

Fig. 7.—Dilatation of duodenum caused by mesenteric obstruction.

opening was patent; the duodenum was dilated with numerous adhesions about the third portion, and the mesentery was moderately tight.

The adhesions were severed by sharp dissection, but a duodenojejunostomy was not performed on account of the tendency to formation of adhesions. Nevertheless the condition of the patient improved.

Case 43.—A man, aged 47, entered the clinic because of vomiting and headaches. For the last year he had had abdominal discomfort after meals and every few days during the last four months he had had attacks of severe headache and nausea, which were relieved by copious emesis. The bowels were costive. He had an eczema of the skin which was resistant to treatment.

Physical examination disclosed a few moist râles at the left apex.

The laboratory findings were normal. Roentgen-ray examination showed dilatation of the second and third parts of the duodenum.

At operation by Dr. G. W. Crile the duodenum was found to be dilated to two or three times its normal size, probably as the result of arteriomesenteric occlusion as the intestines appeared normal beyond that point. A duodenojejunostomy was performed and complete relief of symptoms followed.

CASE 44.—A woman, aged 26, came to the clinic complaining of metrorrhagia, headaches and vomiting. For years she had had postprandial attacks of epigastric distress with nausea, vomiting and belching, together with severe headaches which were relieved by copious emesis of bile stained fluid. During the preceding year she had had metrorrhagia and leukorrhea for which dilatation and curettage had been done five months before. The attacks of vomiting were more frequent during the menstrual periods, which were irregular. She was becoming progressively weaker.

On examination tenderness to pressure was found to be present over the entire abdomen but chiefly in the right iliac fossa.

The laboratory findings were normal. Roentgen-ray examination showed duodenal stasis and gastroptosis with atony. The second and third portions of the duodenum showed dilatation with stasis. There was vigorous peristalsis and the stomach was dilated and atonic, its lower pole being 5 inches (12.7 cm.) below the iliac crests.

Operation by Dr. T. E. Jones disclosed a dilatation of the second and third portions of the duodenum which was caused by arteriomesenteric occlusion. A duodenojejunostomy was performed and complete relief of symptoms followed.

CASE 45.—A woman, aged 26, entered the clinic complaining of abdominal pain and distress after meals. One year before she had been operated on for appendicitis but the symptoms had returned. The pain, which was in the epigastric region and occurred soon after meals, was sometimes very severe and was relieved only by the vomiting of bile stained, sour fluid. Her diet was modified but to no avail.

Laboratory findings revealed normal blood and urine.

An exploratory laporatomy was performed by Dr. H. G. Sloan, at which the duodenum was found to be dilated to three times its normal size. On slipping the finger under the superior mesenteric artery a definite tightness and tugging could be demonstrated.

A duodenojejunostomy was performed, and was followed by relief of symptoms.

CASE 46.—A woman, aged 63, entered the clinic complaining of pain in the right side of the abdomen with fever, loss of weight, weakness and constipation. She had been apparently well until one year before, when she became aware of an occasional dull aching pain in the right side of the abdomen with flatulence and sour stomach. She had increasing constipation and her appetite was poor.

Two months before she had been kept in bed for two days by a sharp attack of pain in the right side, with the appearance of a lump in the upper abdomen. This attack was accompanied by an elevation of temperature. The lump disappeared after copious emesis. For weeks after this attack she had occasional distress, and later another attack similar in character to the first; the swelling as before disappeared after vomiting. The bowels were costive.

Physical examination revealed an emaciated, poorly developed woman. The abdomen was thin walled, was flat and freely movable. There was a palpable tender swelling in the right upper quadrant.

The blood and urinary findings were normal.

The diagnosis of cholecystitis was made. At operation by Dr. G. W. Crile a large dilated duodenum was found. The patient's pulse became poor and the operation was confined to a narrowing of the lumen of the duodenum by blocking it with silk sutures.

The symptoms disappeared but one year later the patient returned and an extensive carcinoma of the sigmoid was found at an exploratory operation by Dr. Crile. No later report has been secured.

CASE 47.—A man, aged 40, came to the clinic because of pain and a sensation of burning in the epigastrium. These symptoms had first appeared eighteen years before, at which time a diagnosis of cholelithiasis had been made. At operation no pathologic condition of the gallbladder had been found; at that

Fig. 8.—Dilatation of duodenum caused by mesenteric obstruction.

time the appendix had been removed. The same symptoms recurred and persisted for eight years when a gastro-enterostomy was done with no resultant relief. The pain and burning had recurred, and he continued to have occasional spells of vomiting. The bowels were costive. A diagnosis of a vicious circle was made.

The physical examination revealed an anemic, pale man; the abdomen was scaphoid but showed no tenderness to palpation.

Laboratory findings revealed normal urine, but the blood showed a secondary anemia.

At operation by Dr. G. W. Crile, the duodenum was found to be markedly dilated to almost the size of the stomach and the gastro-enterostomy opening was practically closed by adhesions. After the adhesions had been severed by

sharp dissection the opening was found to admit three fingers. The enlarged lumen of the duodenum was narrowed by blocking the canal with interrupted silk sutures.

The patient's condition improved.

CASE 48.—A woman, aged 30, entered the clinic complaining of pain in the abdomen. For thirteen years she had had pain in the abdomen, radiating to the intrascapular region, which she attributed to a strain from mountain climbing. The pain was not accompanied by nausea or vomiting. The bowels were very costive. She had frequent severe attacks of headache. Examination revealed a poorly nourished, asthenic woman with rather a yellowish tint to the skin; the abdominal wall was lax, and there were evidences of gastroptosis. The blood and urine were normal.

Roentgen-ray examination revealed gastroptosis and delayed emptying of the duodenum.

Dr. G. W. Crile performed a duodenojejunostomy and appendectomy and complete relief of symptoms resulted.

CASE 49.—A woman, aged 29, entered the clinic complaining of distention of the abdomen and vomiting which had lasted for one year. The ankles were considerably swollen and the eyes were puffy. She had occasional severe headaches, which were followed and relieved by copious emesis which gave evidence of stasis (fluid or food was retained for ten hours). The vomitus was bile stained. Occasionally she had pain in the abdomen. During the preceding ten weeks she had lost in weight from 125 to 114 pounds (56.7 to 51.7 kg.). The bowels were costive.

Examination revealed an anemic, undernourished woman, with evidence of gastroptosis. A splashing sound was elicited by pressure above the umbilicus.

Roentgen-ray examination showed coloptosis and gastroptosis and gave evidence of duodenal stasis with dilatation of the bulb and of the first and second portions of the duodenum. The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 4,024,000; white blood cells, 5,400; differential count, normal. Gastric analysis revealed: free acid, 36; total acid, 59.

At operation by Dr. G. W. Crile, it was found that the dilatation stopped abruptly where the duodenum passed under the root of the mesentery. A duodenojejunostomy was performed and complete relief of symptoms followed.

CASE 50.—A man, aged 45, entered the clinic complaining of headaches and vomiting. A past history of two attacks of typhoid fever at the ages of 15 and 35 years, respectively, was elicited. He had had recurrent headaches almost all his life. These had recently been less severe but more frequent. These headaches were usually in the region of one temple or the other, and lasted from twelve hours to from one to three days. He was nauseated and frequently vomited, with resultant relief of the headache.

The case was diagnosed as migraine and was treated medically with diet and luminal, but the symptoms persisted for the following two years when the patient came to the clinic.

Physical examination failed to elicit any important points.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 80 per cent.; red blood cells, 3,470,000; white blood cells, 5,700; differential count, normal.

Roentgen-ray examination showed duodenal stasis and dilatation of the second and third parts of the duodenum.

At operation by Dr. T. E. Jones the duodenum was found to be markedly dilated, and the pylorus was open admitting two or three fingers. It was evident that mesenteric obstruction was the cause of the dilatation. A duodenojejunostomy was performed and complete relief resulted.

Case 51.—A woman, aged 30, entered the clinic complaining of sick headaches and goiter. She stated that for sixteen years she had been subject to sick headaches accompanied by vomiting, the vomitus being dark green. The headaches occurred usually in the morning and were relieved by the vomiting, which usually occurred about noon. The bowels were costive.

Fig. 9.—Dilatation of duodenum with duodenal ulcer.

The only significant points disclosed by physical examination were a colloid goiter and evidence of visceroptosis.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 90 per cent.; red blood cells, 4,020,000; white blood cells, 8,300.

Roentgen-ray examination showed an elongated and dilated descending duodenum with antiperistalsis. The stomach and duodenal bulb were normal.

At operation by Dr. G. W. Crile, the duodenum was found to be dilated as far as the point where it passed under the mesentery; from there on it appeared to be normal.

A duodenojejunostomy was performed, and freedom from symptoms resulted.

CASE 52.—A man, aged 31, entered the clinic complaining of headaches and vomiting. There was a past history of pneumonia and pleurisy. For sixteen years he had had attacks of headache, with nausea and vomiting, which had become progressively worse and more frequent until he was experiencing them from four to six times a month. The attacks began with pain over each temple followed by nausea and vomiting. A diagnosis of migraine had been made, medical treatment for which had failed to give relief.

Physical examination was negative except for evidences of gastroptosis and coloptosis. The laboratory findings were normal. Roentgen-ray examination revealed dilatation of the second and third portions of the duodenum and 25 per cent. retention in the stomach after four hours.

At operation by Dr. G. W. Crile the duodenum was found to be dilated and obstructed at the point where the duodenum passed under the mesentery. A duodenojejunostomy was done, and an immediate relief of symptoms resulted, but the interval of time since operation has been too brief to warrant definite conclusions as to the permanency of the cure.

CASE 53.—A man, aged 42, entered the clinic complaining of abdominal pain, vomiting and loss of weight. He gave a past history of typhoid fever at the age of 14, appendectomy seven years before, and of a plastic operation for duodenal ulcer four years before. For three years after the last of these operations he had no trouble, as he adhered to a fairly strict diet. During the preceding year, however, the patient had vomited at intervals, sometimes twice daily and sometimes only once a week. There was slight pain before emesis. He had lost 12 pounds (5.4 kg.) in weight. The vomiting was becoming progessively worse. The bowels were costive.

Examination revealed a poorly developed, rather emaciated man with a blood pressure of 90 systolic, 60 diastolic. The abdomen was scaphoid. Palpation was unsatisfactory.

The laboratory findings were: urine, normal; Wassermann reaction, negative; hemoglobin, 85 per cent.; red blood cells, 4,340,000; white blood cells, 11,000.

Roentgen-ray examination showed the niche of a penetrating ulcer on the lesser curvature in the media of the stomach, and very much dilated second and third portions of the duodenum which suggested the presence of adhesions that had caused stenosis of the distal duodenum.

Dr. W. E. Lower resected the lower portion of the stomach containing the ulcer and performed a gastro-enterostomy (Billroth II).

The ulcer was considered to be the major pathologic condition in the case, accounting for the type of surgical procedure.

Twenty days later the patient was free from symptoms. This case is also too recent to permit conclusions as to the permanency of the cure.

CASE 54.—A man, aged 38, entered the hospital complaining of pain in the abdomen. He had had a previous gastro-enterostomy and appendectomy following which he had had occasional attacks of pain. For five years he had had a dull throbbing pain in the right side. He had attacks of vomiting and headaches at intervals with attacks of cramps in the stomach and soreness and pain after meals. The bowels were costive.

Examination revealed a fairly well developed man with evidences of gastroptosis. There was tenderness to palpation in the region of the pylorus.

The laboratory findings were: urine, normal; Wassermann reaction, negative; blood, normal.

Roentgen-ray examination showed that some barium passed by way of the pylorus, a distorted duodenal bulb and stasis at the knee of the second and third parts of the duodenum. There was from 25 to 30 per cent. retention in the stomach, a dilated duodenum and jejunum in five hours.

At operation by Dr. G. W. Crile the jejunum also was found to be dilated. A resection of the previous gastro-enterostomy with an end-to-end anastomosis of the jejunum was performed, and the patient was discharged from the hospital in an improved condition.

CASE 55.—A woman, aged 42, entered the clinic because of headaches and attacks of pain in the right upper quadrant of the abdomen with vomiting. She had suffered from these attacks for years. An appendectomy, a cholecystostomy, a cholecystectomy, and severance of adhesions to the common duct had been performed but without giving her any relief. The attacks had increased in frequency and seemed to occur in cycles of two weeks. During the attacks the patient vomited the contents of the stomach followed by a considerable amount of bitter, dark bile. During the attacks she sometimes experienced severe pain in the region of the gallbladder, radiating to the back and right scapula. The headaches were frontal in type, dull aching in character and were relieved by vomiting. There had been a slight loss in weight.

Examination revealed a well developed woman, slightly anemic.

The laboratory findings were normal.

Roentgen-ray examination revealed a marked dilatation of the duodenum with stasis. The stomach and duodenal bulb were normal.

This patient is to return later for duodenojejunostomy. She has been operated on five times without any relief from symptoms. I believe the correct diagnosis has now been established and that the duodenojejunostomy will result in a cure.

CASE 56.—A man, aged 35, entered the clinic complaining of burning pain in the stomach for the relief of which an appendectomy had been performed ten years before but without avail. Since that time the distress had recurred at intervals and recently had been more or less constant and was sometimes accompanied by headaches and nausea; occasionally he had dizzy spells. A diagnosis of duodenal ulcer had been made and the patient had been put on a Sippy diet without relief.

Physical examination revealed an undernourished man. The abdominal wall was flaccid and the transverse colon was palpable; some tenderness was felt over the gallbladder.

The laboratory findings were: urine, normal; hemoglobin, 80 per cent.; red blood cells, 4,490,000; white blood cells, 6,800. Gastric analysis revealed: total acidity, 27.5; free hydrochloric acid, 10.5.

Roentgen-ray examination showed a dilated bulb and duodenum; the stomach was normal.

A diagnosis of dilatation of the duodenum was made and a duodenojejunostomy performed with complete relief of symptoms.

CASE 57.—A man, aged 42, entered the clinic complaining of nervousness, weakness and loss in weight. There was a past history of typhoid and pneumonia. The appetite was fair, and he had no gastric symptoms except for gas in the intestines. The bowels moved fairly well. He had occasional attacks of diarrhea, but never any blood or mucus in the stools.

Examination revealed palpable masses in the colon which felt like fecal material. The blood pressure was 104 systolic, 80 diastolic.

The laboratory findings were: urine, normal; Wassermann reaction, negative; phenolsulphonephthalein, 52 per cent. in two hours; hemoglobin, 80 per cent.; red blood cells, 4,750,000; white blood cells, 7,800; differential count, normal.

Roentgen-ray examination revealed an irregular constriction and dilatation of the second and third portion of the duodenum. The stomach and duodenal bulb were normal, the cecum mobile and the ascending colon ptosed.

A diagnosis of dilatation of the duodenum was made and operation advised. The patient is to return later.

PUNCTURE WOUNDS OF THE CEREBELLUM

INJURY OF CEREBELLUM BY FOREIGN BODY ENTERING THROUGH JUGULAR FORAMEN, WITH REMOVAL AND RECOVERY

HAROLD L. FOSS, M.D.
DANVILLE, PA.

In this day when one hardly dares submit a clinical report unless it is based on a large experience and is authoritative and acceptable from numerical vastness, if from nothing else, one cannot feel justified in detailing his clinical experiences with a "series of one case" unless that case is sufficiently extraordinary to be of unusual interest.

Puncture wounds of the cerebellum are common enough, especially in time of war, but a penetrating wound of the cerebellum from an object entering the jugular foramen by way of the mouth is an extremely rare injury, while deep puncture of the cerebellum by a foreign body by this route, with removal of the body followed by recovery of the patient, is so unusual that the occurrence of such a case seems worthy of report. I find no similar example in the literature of recent years while a search through fifty older articles carrying general titles but touching on cerebellar injuries failed to reveal one.

Huppert [1] says concerning the penetration of the cerebellum by a foreign body, whether extracted or not, that the result is almost invariably fatal. In fact, this was the usual testimony, at least prior to the Great War; hence, it is exceedingly remarkable that a person should have survived a deep puncture of a cerebellar lobe when the object was a large and blunt one and when that object entered through the jugular foramen. Necessarily it was in the closest proximity to structures of no less importance than the ninth, tenth and eleventh cranial nerves, the inferior petrosal sinus, the lateral sinus, and the meningeal branches from the ascending pharyngeal and occipital arteries. Such a patient has recently been under my observation.

I was inclined seriously to question the possibility of such an injury as that interpreted by the roentgenologist, who telephoned his diagnosis to me, and was unconvinced until I had examined the plates and, later, the patient. That the object had traversed the lateral wall of the pharynx, had entered the jugular foramen, and had penetrated the left cerebellar hemisphere to a depth of 5 cm. could not be questioned.

REPORT OF CASE

History.—S. H., a boy, aged 2½ years, was admitted to the hospital on the evening of March 28, 1923. The mother said that about one hour before the child, while running with a double ended ivory crochet hook in its mouth,

1. Huppert: Arch. f. Heilk. Berl. **6**, 1875.

tripped, fell forward on his face and immediately began violently coughing and vomiting. In a moment or two he coughed out one-half the hook, which had broken at its center, and, as the remainder could not be found, it was supposed that it had been swallowed or insufflated. The child, although fully conscious, seemed totally unable to talk or cry. For a few minutes there was slight bleeding from the nose. The patient was at once placed in an automobile and sent to the hospital, some fifteen miles distant.

Physical Examination.—The patient was well nourished and developed. He lay quietly on the cot, occasionally coughing and vomiting. He neither talked nor cried, and seemed unable to do either. The pulse was 110, the temperature normal, the respirations slightly hurried and accompanied by a wheezing inspiratory stridor. There was a large quantity of mucus and vomitus in the mouth and throat, which the patient seemed unable to expel. On its removal and on examination of the mouth and pharynx, no lacerations were discovered and no sign of the missing crochet hook. The general physical examination, hurriedly made at this time, was negative.

The patient was immediately examined fluoroscopically with the full expectation of finding the missing object in the upper air passages or in the alimentary tract. No evidences of it were found in the abdomen or in the thorax. It was almost by accident that the screen was moved over the child's head revealing the metal end of the hook in the upper pharynx, and, on lateral view, it was found to project into the left cerebellar hemisphere for nearly its entire length. Stereoscopic plates were made, immediately developed, and the hook definitely localized in the brain.

The patient was at once prepared for operation. Since nitrous oxid caused profound cyanosis, it was discarded for ether, but even then with only partial success. With the aid of mouth gag and head mirror a tiny punctured wound was found in the upper portion of the left anterior tonsillar pillar through which a probe could be passed for 5 or 6 cm., at which point it came into contact with the metal screw on the end of the lost crochet hook. It was necessary to incise the tract so as to admit forceps, several of which were tried before a satisfactory one was found. Finally, a long Hagar needle holder being used, the screw on the end of the ivory hook was grasped, and, with a slight rotating motion, the hook removed. The object was firmly fixed, and a surprising amount of traction had to be used before it could be loosened. When it finally came away there was a sudden and profuse hemorrhage from the wound which was at once controlled by a long iodoform gauze pack. The child's respirations at once ceased. For ten minutes artificial respiration had to be resorted to, after which period the patient began to breathe again; in a few minutes he was breathing naturally.

When the patient returned from the operating room his temperature was 97 degrees, pulse 120, and respirations 50. That night the patient vomited slightly and coughed occasionally. Extreme restlessness was finally controlled by codein. On the following day the pack was removed. Twenty-four hours after the operation the left eyelids became slightly swollen, and, at the same time, the left ear became discolored. During the first few days there were wide fluctuations in the temperature but by the ninth day both temperature and pulse were normal. Following the operation, and until the patient left the hospital, thirteen days later, he experienced great difficulty in swallowing, much of the liquid food returning through the nose. There were no urinary changes other than an increase in the specific gravity, and no glycosuria (Claude Bernard).

The second day the eye grounds were negative and neither strabismus nor nystagmus were present. The child lay quietly in bed, and, except for great difficulty in swallowing, seemed quite normal. There apparently was no involvement of the facial nerve and no changes in the reflexes.

The fourth day the patient had difficulty in swallowing. The food regurgitated through the nose. Talking was difficult. Apparently there were no visual disturbances.

Fig. 1.—Anteroposterior view within an hour of the accident, showing shadow of handle of crochet hook with steel screw.

The fifth day the patient was out of bed. There was a tendency for the child to fall to the left when walking, and it was impossible for him to walk in a straight line. He swallowed better with no regurgitation through the nose. At no time were there evidences of meningitis.

The sixth day the ataxia was less pronounced but the patient still displayed some tendency to fall to the left, these being the only signs of dysmetria or

asynergia exhibited. He talked better and swallowed much better. At no time were there convulsions.

The thirteenth day the patient was discharged. He still showed a slight tendency to veer to the left and had some difficulty in swallowing.

For five or six weeks after returning home the child experienced slight difficulty in swallowing. The mother was obliged, therefore, to be cautious in selecting his food. Solids could be taken only with great difficulty for on such occasions the patient would "choke up" and regurgitate froth and mucus. For several weeks speech was impaired but it finally became normal. For a long time the patient talked only in a whisper.

He was reexamined, November 29, ten months following the injury, at which time the patient seemed normal in every particular.

I reported the case to several neurologists, who have kindly permitted me to add their comments to this paper.

Dr. William G. Spiller: The case you describe in your letter is one of exceptional interest. It is remarkable that the child had no hemorrhage and had so little reaction. The course of the crochet hook seems to indicate that the foreign body passed to one side of the medulla oblongata, and thus escaped injuring vital structures. The great danger now is from infection, and if it escapes this, there may not be any serious symptoms. The point of entrance into the skull was through the jugular foramen, and yet the hook avoided the inferior petrosal sinus, the lateral sinus, the meningeal arteries, and the ninth, tenth and eleventh nerves. The facial and acoustic nerves were not far away. It is difficult to examine all these nerves in a young child, and there may be some injury which cannot be detected at present.

Dr. F. X. Dercum: I am greatly interested in the very remarkable case which you describe. Like yourself, I know of no similar case. Both the accident and the outcome are most extraordinary. It seems almost impossible that the inferior petrosal sinus and the lateral sinus or the glossopharyngeal and spinal accessory nerves should have escaped. Of course the difficulty in swallowing and regurgitation might be accounted for by injury of the glossopharyngeal, but this, according to the history, seems not to have been serious in nature, for the symptoms early disappeared. You no doubt examined the child for hemiasynergia, dysmetria, adiadokokinesis and allied symptoms, and, if they were absent, this would confirm the view that the injury of the cerebellum was limited to the lateral lobe.

Subsequently, he wrote: I have examined your plates and there can be no doubt as to the position occupied by the crochet needle and I cannot but again express my amazement at the recovery. I am returning the plates by this mail. I feel under great obligations to you for permitting me to see them. I trust that you will now publish your paper without further delay.

Dr. Walter E. Dandy: Your case is indeed an interesting one. It was certainly a far-seeing needle to have ever been able to find the jugular foramen. I wonder if the child had convulsions either at that time or subsequently. There is no reason why it should have had them but it would be very interesting to know that it did not. There are, of course, many cases of foreign bodies, but none that I know that entered through the jugular foramen.

Dr. Charles A. Elsberg: The case you describe in your letter is certainly a very interesting one and a most unusual accident. I have never seen nor heard of an injury of this kind. I have, however, seen a child who fell with a buttonhook in its mouth and sustained a puncture wound of the nasopharynx with a perforation into the cranial cavity. When I saw the child, she had the

signs of a meningitis to which she rapidly succumbed. I think the result you obtained in your remarkable case is an excellent one.

Dr. C. H. Frazier: I have read with much interest the account of the puncture wound of the left cerebellar hemisphere. So far as I can recall, we have no record of an injury of that nature. Of course the attacks of respiratory failure associated with lesions of the posterior fossa, and particularly cerebellar tumor, have been observed often and, as you no doubt know, in some cases life has been prolonged by artificial respiration from eighteen to twenty hours. That is, the patient survived eighteen hours or more after voluntary respiration had been wholly lost. Recovery in your case is extremely gratifying.

Fig. 2.—Lateral view within an hour of accident, showing shadow of crochet hook in jugular foramen and cerebellar fossa.

Dr. A. W. Adson: I have never personally had a case of this kind and, off hand, I do not recall having heard of one. I think that it would be well worth while to go into the case fully and report it.

Dr. Harvey Cushing: I am glad to have the details of this extraordinary case. I am quite sure that I have seen records of similar episodes, and it is an old wives' caution for children that they must not run about with sharp pencils or scissors in their hands lest they get their brains punctured. However, that the weapon should be a crochet needle and that it should go through the jugular foramen is such an unusual combination of circumstances as to justify a clinical report of the case.

PHYSIOLOGY OF CEREBELLUM

Although our knowledge of cerebellar physiology is extremely limited, we do know that severe injuries of the cerebellum produce certain phenomena, known collectively as the "cerebellar syndrome," consisting chiefly of ataxia, the component parts of which are: dysmetria, a term used to designate disturbances in the performance of voluntary movements; asynergia, or lack of synchronization, and adiadokokinesis, an inability to execute voluntary movements successively and rapidly.

In some way the cerebellum exerts a regulatory influence on the nervous mechanism, thus controlling voluntary movements, and we may

Fig. 3.—Position of wound of entrance in left anterior tonsillar pillars.

accept the original idea of Floureus (1824) that the organ is a coordinating center for the complex voluntary movements utilized in producing locomotion and in maintaining equilibrium.

Cerebellar influence on body musculature is homolateral; that is, each hemisphere is associated with its own half of the body; while its connection with the motor area of the cerebrum is just the reverse, the right cerebral hemisphere being in relation with the left half of the cerebellum. The degrees of consciousness shown by the small brain is slight, or, at least, of a much lower order than that of the cerebrum, since experimental removal of the cerebellum produces no apparent loss of sensation (Howell).

In animals, experimental removal of all or part of the cerebellum produces no striking evidences of muscular paralysis, but, instead, a curious lack of power to coordinate properly the contractions of the various muscles involved in the maintenance of equilibrium. Following cerebellar resection pigeons are unable to fly, and they walk with a staggering, drunken gait, a condition designated as cerebellar ataxia.

Unilateral operations on the cerebellum of mammals give somewhat similar results. If one hemisphere is resected, there is a tendency to forced movements directed toward the injured side, a turning or rotation of the body to left or right.

In human beings afflicted with cerebellar atrophy or neoplasm, the fundamental symptom is lack of accurate coordination, as manifested by an ataxic gait and lack of skill in performing definite movements that require the associated activity of several muscles.

A review of the more notable case reports in the literature of cerebral and cerebellar traumatism by puncturing objects may at this time be of interest.

Slee:[2] A plumber, aged about 30, was shot in the abdomen and thigh; he was operated on and death followed two days later from general septic peritonitis. Necropsy, Feb. 15, 1890, revealed a knife blade 5/16 inch wide penetrating 1 inch (2.5 cm.) into the left occipital lobe. The point of the blade was ensheathed in a strong fibrous capsule; there was no depressed or displaced bone; the blade was black, corroded and showed signs of having been in position for years. Inquiry showed that the man's family had never known of an injury that had caused cerebral or other symptoms during life.

Delanglade:[3] A man, aged 17, fell from a ladder a distance of 2.5 meters; an open knife held in the hand penetrated 4 cm. into the frontal lobe and 3 cm. above the orbital margin. The knife blade was extracted by traction in the direct axis of the blade. There were no hemorrhages, and no sutures were taken. Treatment was given with compresses, and recovery followed in twelve days. No after symptoms were noted and no injury to the eye except a slight degree of ptosis.

Vallas:[4] A man, a mason, had a stone weighing 2 kg. fall on his head; a few days later he suffered the onset of jacksonian epilepsy and right hemiplegia. Physical examination revealed a 2 cm. long knife blade in the left side of the brain. Extraction of the blade was followed by death two days later from diffuse meningitis. Necropsy showed that a blade had pierced the paracentral lobe. Inquiry revealed that a knife blade had been in the brain for two years as the result of a brawl, but that it had caused no cerebral symptoms.

Kennedy:[5] A boy, aged 3½ years, while wearing a straw hat, fell on an iron spike which penetrated the head 1 inch (2.5 cm.) above the right ear and car-

2. Slee, R.: A Knife Blade Found in the Brain Years After Its Entrance, Death Resulting from Other Causes, Med. News **59**:95-96 (July 25) 1891.

3. Delanglade: Penetration of a Large Knife in the Brain Across the Orbit, Marseille méd. **38**:681-684, 1901.

4. Vallas: Foreign Body in Brain, Lyon méd. **98**:362-364, 1902.

5. Kennedy, R.: Case Presenting a Sinus Which Traversed the Cranium Completely and Contained Some Portions of a Straw Hat Carried into the Brain by Means of a Spike, Glasgow M. J. **63**:42-44 (Jan.) 1905.

ried pieces of straw into the brain. No immediate symptoms followed. Three and one-half months later he suffered drowsiness, febrile disturbance, headache, vomiting and the wound was discharging pus. Examination under anesthesia revealed a large sinus traversing the temporosphenoidal lobe of the brain to the opposite side of the skull which was filled with pus and short pieces of straw. The sinus was cleared out, packed with iodoform gauze, and drained. Complete recovery took place two months later. Examination two years and four months after operation showed the patient to be in excellent physical and mental health.

Gallemaerts:[6] A girl, aged 5 years, fell while running with a crayon in her hand; the pencil penetrated the left internal canthus 3 cm. into the frontal lobe; it

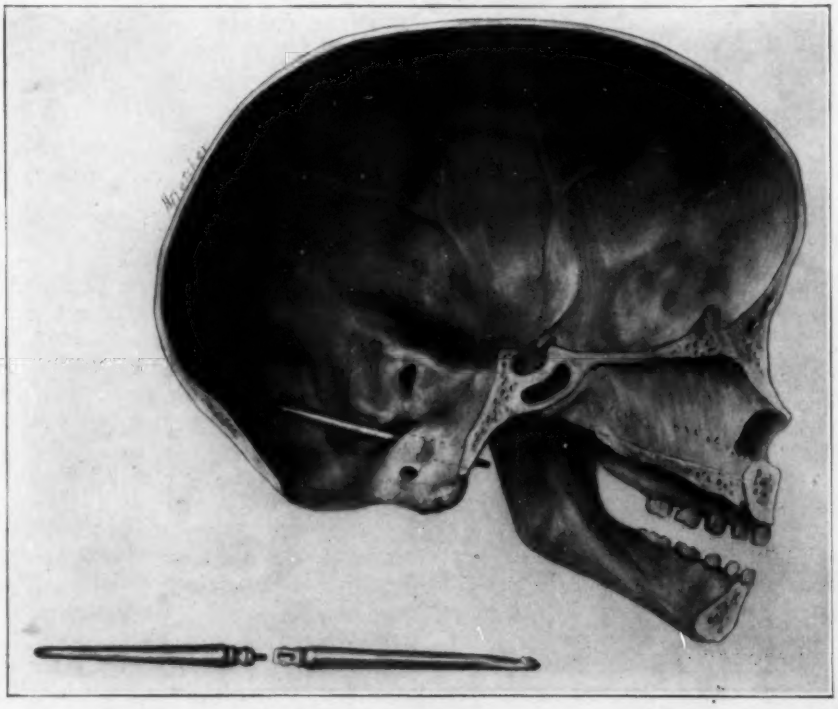

Fig. 4.—Probable position taken by instrument in left jugular foramen and cerebellar fossa.

remained there twenty-four hours before it was extracted with a forceps. Infection followed. Deep drainage was instituted and there was complete recovery after two months. No cerebral or ocular symptoms were noted. One year later the patient died apparently from influenza. Necropsy showed complete softening of the frontal lobe due to a streptococcic abscess extending from in front of the lenticular nucleus to a region of the third ventricle. An abscess had developed gradually, provoking no cerebral trouble but causing pupillary stasis.

6. Gallemaerts, E.: Foreign Body in Brain (Colored Crayon) Penetrating Through the Orbit, Presse oto-laryngol. belge **10**:529-535, 1911.

Blaine:[7] A Slav, aged 43, fell from a wagon, striking his head on the pavement; he had headache and vertigo. Roentgen-ray examination revealed a knife blade 1.5 cm. wide and 8 cm. long extending from the right frontal bone to the middle and posterior ethmoid region. Left sided body retardation suggested that the blade had been embedded for the last twenty years; the real cause of the injury could not be learned. A lumbar puncture was made; the Wassermann reaction and the spinal fluid were negative. The patient was discharged after a few days in normal condition.

Gessner:[8] A chauffeur, aged 34, had a hemorrhage from the left ear and received a diagnosis of probable fracture of the base of the skull. Nine days later he had complete left hemiplegia and was in a sluggish mental condition; the eye grounds were normal. Roentgen-ray examination showed a 2 inch (5 cm.) knife blade stuck through the vertex on the right near the anterior superior angle

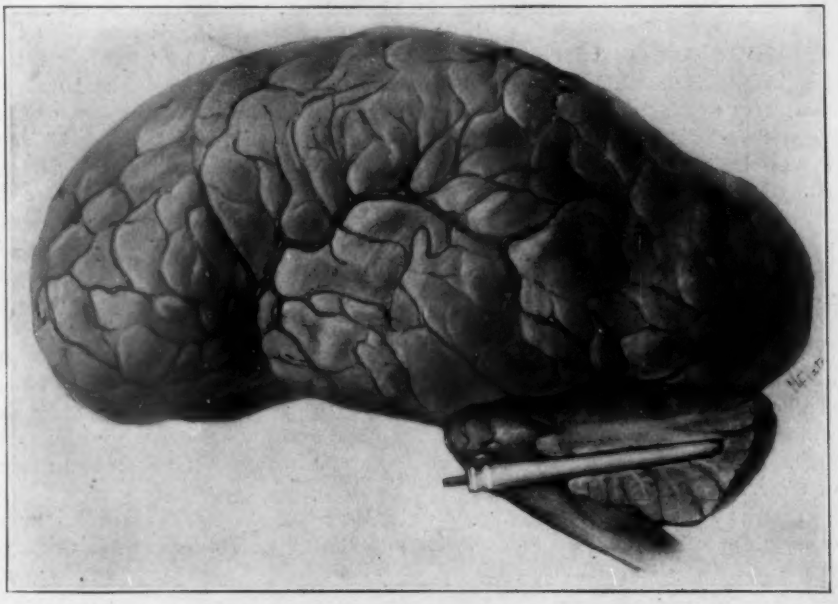

Fig. 5.—Probable position of instrument in left cerebellar hemisphere.

of the parietal bone. An operation for removal of the knife blade was performed on the eleventh day, and one half ounce (15 c.c.) of pus was drained from the track. A cigaret drain was established, with iodoform gauze and bone wax packing. The drain was removed on the thirteenth day, and there was complete and uninterrupted recovery.

McLean:[9] A girl, aged 5 years, was kicked in the head by a horse; the depressed fracture resulting was operated on at once. A stormy convalescence

7. Blaine, E.: Knife Blade in Brain; Roengen-Ray and Clinical Findings, Am. J. Roentgenol. **4**:622-624.

8. Gessner, H. B.: Removal of a Foreign Body from Brain, New Orleans M. & S. J. **69**:636-638 (March) 1917.

9. McLean, S. H.: A Piece of Steel in the Brain Eighteen Years, South. M. J. **11**:245 (March) 1918.

was followed by recovery six weeks later. At the age of 23, the patient had headaches and twitching of the foot and of the leg. In October, 1915, at operation, a forceps blade 2½ inches (6.27 cm.) long was found between the dura and the skull and was removed. Complete recovery followed one week later, and she was enjoying perfect health two years after the operation. The steel object had been in the brain for eighteen years.

Reynes:[10] A man, aged 25, who was insane, in an attempt to commit suicide tore two picture nails 3½ cm. long from the wall and with a stone drove both nails into the top of his head. No fever, hemorrhage or meningeal symptoms resulted. Some days later, when he confessed the suicidal attempt, physical examination revealed two small scars in the median line of the scalp. Roentgen-ray examination showed two nails embedded in the brain; these were successfully removed with a forceps. A few days later the patient drove a needle into the brain through one of the wounds. Slight symptoms followed. The needle was successfully removed. He died some years later from an unknown cause.

Davison:[11] The patient had engaged in a fight and had been stabbed in the left side of the head with a pocket knife, after which he was unconscious for two hours. He slept well that night, was up early the next morning and walked two miles to his own home, where he ate heartily and had no symptoms except from the slight scalp injury; three days later he "turned sick and blind," and though he could still walk he went to bed. On the seventh day the patient noticed a tingling in the foot, leg and hand on the right side. Numbness and finally paralysis developed. He lost control of his bladder and rectum. He did not remember events during the third week, and had only a hazy recollection of being taken to the hospital. There was then complete hemiplegia of the right side. The patient was in a semicomatose condition, although he could be aroused. Roentgen-ray examination showed a knife blade 1⅛ inches (2.8 cm.) in length in the skull, in the left rolandic area. The author trephined, removing a section of bone 2.5 by 3 cm. with the knife blade in the center. When the section of the skull was lifted, the dura was exposed showing an opening by the blade through which exuded a thick greenish yellow pus. The brain was not pulsating in this area. A crucial incision was made in the dura which exposed an abscess the size of a hen's egg. Recovery followed.

Flesch:[12] A woman, aged 34, was shot twice with a revolver of 7.5 mm. caliber; one of the bullets entered the skull and was localized roentgenologically in the left hemisphere. A paralysis of the left upper and lower extremities soon disappeared. Ten weeks after discharge from the hospital the woman complained of left occipital headache. Roentgen-ray examination disclosed that the bullet now lay in the left occiput. The migration could hardly have resulted through abscess formation or gravity. It was assumed that this might have taken place by way of the lateral ventricle, and experiments on cadavers made this theory seem plausible. At operation, two years later, the bullet was actually found in the left lateral ventricle. Recovery was made.

The literature of cerebellar injury was considerably enriched during the war; some of the papers of this period are mentioned here.

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10. Reynes, H.: A Strange Attempt at Suicide; a Degenerate Hammers Two Nails into His Brain with a Stone, Bull. Acad. de méd. **84**:102-103 (Oct. 5) 1920.

11. Davison, T. C.: Knife Blade in Brain, J. M. A. Georgia, **11**:267 (July) 1922.

12. Flesch: Migration of a Projectile into the Lateral Ventricle Confirmed by Operation, Arch. f. klin. Chir. **121**:56 (Dec. 14) 1922.

Milligan [13] reported in 1916 a case of a soldier wounded at Ypres by a piece of shell which, passing through the skull, had entered the anterior portion of the left cerebellar lobe. Severe hemorrhage resulted,

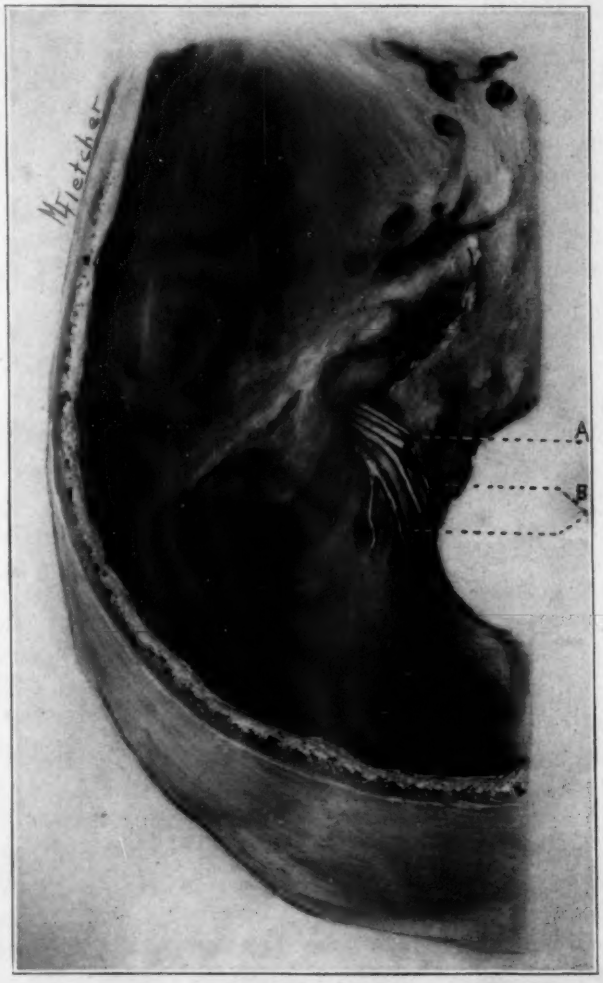

Fig. 6.—Anatomic structures entering or leaving jugular foramen: *A*, glossopharyngeal, pneumogastric and spinal accessory nerves; *B*, meningeal branches from ascending pharyngeal and occipital arteries.

possibly from the lateral sinus. When seen a suppurating sinus led down to the foreign body. Removal was easily effected and complete recovery ensued.

13. Milligan, W.: Removal of a Piece of Shell from the Cerebellum of a Soldier Wounded at Ypres, Proc. Roy. Soc. Med., London, Otol. Sect. **9**:31, 1915-1916.

In an article on gunshot injuries of the cerebellum published in 1917, Holmes [14] states that the cerebellum may be regarded as a "motor reinforcing organ." "It seems probable that it takes no direct part in the processes that produce motor effects, whether initiated reflexly or voluntarily, and that it does not augment these, but that it tunes or regulates the activity of certain motor mechanisms, most probably spinal, so that the response to a volitional stimulus is immediate, effective and proportional to the intensity of the cerebral impulse. Astasia is not such a prominent symptom in most local lesions of the cerebellum in man as in animals after experimental destruction, though it varies in degree in different cases. Clinical observations confirm Luciani's conclusions that atonia, asthenia and astasia, the triad of symptoms to which he attributes all the function disturbances, result from cerebellar lesions."

Holmes found with the cerebellum cases under his observation that in many instances the primary wounds were large and the softenings, hemorrhages and septic processes that so frequently accompany such injuries undoubtedly increased the extent of the destruction. The majority of wounds involved the posterior inferior surface of the cerebellum; most of them were referred to the lobus gracilis, but practically every region except the anterior superior portion was affected in one or more cases.

In two patients fragments of bone were driven along the under surface of the tentorium, so that the injury was limited to the superior surface. In others missiles had entered through the occipital or parietal lobes and had penetrated the tentorium. Thus far Holmes has found no definite evidence of localization in the cerebellum. Holmes' findings do not agree with Bárány's views as to functional localization. He says, however, that there can be no doubt that the relative prominence of different symptoms, such as tremor, slowness and incoordination of movement, as well as nystagmus, varies with the site of the lesion.

Holmes in another article cites the case of a man who, in an attempt to commit suicide eight years before the article was written, shot himself through the mouth and produced extensive destruction of one lateral lobe of the cerebellum, in which fragments of metal still remained. Another patient had been wounded by fragments of shell casing twenty months before and had been trephined over the lateral lobe. Details of the results seem to be wanting.

A remarkable case is reported by Jefferson [15] of a Tartar boy, aged 18, a chauffeur who was struck by a bullet 12 cm. above and 1 cm.

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14. Holmes, G.: The Symptoms of Acute Cerebellar Injuries Due to Gunshot Injuries, Brain **40**:461-535, 1917.

15. Jefferson, G.: Removal of Rifle Bullet from Right Lobe of Brain, Illustrating the Spontaneous Movement of a Bullet in the Brain, Brit. J. Surg. **5**:422, 1918.

behind a line drawn vertically upward from the preauricular point. The bullet track ran downward and backward. Roentgen-ray examination revealed the bullet lying in the right cerebellar fossa. The object lay obliquely, with its nose downward, inward and forward, suggesting that it had been deflected after entering the skull. It apparently was embedded 3 cm. deep in the right lobe of the cerebellum. The chief localizing signs were nystagmus toward the right, a tendency to fall always toward the right, and right sided dysdiadokokinesia. When another roentgenogram was made nineteen days after the injury, the bullet was shown to have sunk backward until it was separated from the inner surface of the occipital bone by barely 1 cm. This general movement backward had been accompanied by version of the bullet, so that its nose which formerly pointed forward, downward and inward, now pointed backward, upward and inward, the general lie of the bullet being now horizontal. The bullet had therefore traversed a distance of 2 cm., its base having gone through a relatively large excursion. The bullet was easily extracted through a trephine opening.

Neuhoff [16] relates some of his war experience in a rather general way. Nothing is said particularly about cerebellar wounds. The total mortality for operated head wounds, including deaths from other causes and deaths after leaving the hospital, was 42 per cent. in dural penetrations in the first series of cases; this was reduced to 29 per cent. in the second series. The author concludes that the ultimate prognosis for patients with craniocerebral wounds after complete early operations is far more favorable and cheering than was generally thought to be the case.

COMMENT

Much has been written regarding traumatic injuries of the brain, especially the cerebrum, and from this literature it is apparent that the individual can survive deep penetrating injuries of this organ even when the object is not removed. Accounts of such injuries involving the cerebellum are extremely rare or, at least, were so until the advent of the medicomilitary literature of the Great War. That penetration of the cerebellum by an object traversing the mouth and entering the skull through a basal foramen is, naturally, most unusual, and careful search of the literature fails to reveal an example. That such an injury can occur and the patient rapidly recover with but slight temporary, and no permanent, disturbances, is shown by the experience of the patient whose history has been described here.

16. Neuhof, H.: The Surgery of Craniocerebral War Wounds and Its Results, Arch. Neurol. & Psychiat. **2**:237, 1919.

GROWTH DISTURBANCES FOLLOWING RESECTION OF JOINTS *

S. L. HAAS, M.D.
SAN FRANCISCO

The advisability for the resection of a joint in a growing individual with intact, epiphyseal cartilage plates is the subject for as much discussion today as it has been during the last century and a half.

It is of considerable interest to recall briefly the early history of joint resection, bearing in mind the added difficulties in the days before antisepsis and anesthesia. The first resection of the hip joint is accredited to Anthony White in 1721, the first resection of the elbow joint to Wainman in 1758, and the first resection of the knee joint to Filkin about the same time. However, the credit for the first successful resection of the knee joint is generally given to Park of Manchester. His patient, a man aged 33, obtained such a good result that he was able later to go to sea.

Of more direct interest because of its bearing on the subject under investigation is the first successful resection of a knee joint on a young patient, by Syme.[1] This operation performed in 1829 on a boy, aged 8, came out so well that he could walk and run without trouble. It was necessary, however, for him to wear a raise of 2 inches (5 cm.) on the shoe of the operated side. From this time on, we find adherents for and opponents to the resection of joints in growing patients.

Brodie,[2] in his book written in 1834, says that amputation is the method of choice in infections that do not clear up.

Humphry [3] in 1858 made the following statement:

> The fact that the growth of a bone in length takes place chiefly through the medium connecting the epiphysis with the shaft has assumed great practical importance since the successful revival of the operation of excision of the knee. It is maintained by some that if the operation be performed in children, the limb will not grow in like proportion with its fellow and therefore will be comparatively useless. This has not been found to be so in all cases, and it is highly probable that the subsequent, proper growth of the limb, will depend in great measure on the quantity of bone that is sawn away. But if care be taken to leave a thin slice of the epiphysis in connection with each of the bones, experi-

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* From the surgical laboratory of Stanford University School of Medicine.

1. Syme, James: Treatise on the Excision of Diseased Joints, Edinburgh, Southerland and Knox, 1831.

2. Brodie, B. C.: Disease of the Joints, London, Longman, Rees, Arme, Brown and Longman, 1834.

3. Humphry, George: A Treatise on the Human Skeleton, London, Macmillian Company, 1858, p. 44.

ence has proved it to be pretty certain that the growth will go on with little interruption and a useful limb will be retained.

Humphry has performed several resections in growing persons, and his statements lead one to believe that he had given a great amount of thoughtful consideration to this subject.

Coote [4] (1867) says:

I am no strong advocate for the operation of resection of the knee joint under any circumstances, and disapprove of it almost unconditionally in children, in whom the limb afterwards becomes year by year weaker, more withered and less equal to the opposite member.

Koenig [5] (1867) reported two successful cases of knee joint resection. One of the patients had a shortening of 1.5 cm., and the other a shortening of 5 cm. He also tabulated 110 other cases by various surgeons, up to that time. He made a study of the variation of the heights of the epiphyseal cartilage from the articular surfaces of both the tibia and the femur at the ages of 11, 16 and 18 years, and gave some useful guides for the protection of the epiphyseal cartilage.

Sayre [6] (1876) practiced resection of joints, but in his lectures says:

If the disease is not sufficient to warrant complete exsection, you may remove all dead bone by drilling and gouging; pass setons of oakum or perforated rubber tubing through the joint for drainage, and conduct the treatment on the general plan recommended when speaking of the management of the ankle joint.

Thomas [7] (1878) says,

As regards excision of joints, my experience will not allow me to endorse the opinion of Professor Spense, that the operation is "so obviously an advance in the right direction," but I have been convinced that it is a step in the wrong direction. In neglected or wrongly handled cases in some cases there is no alternative and excision is indicated.

In 1892 Whitman [8] came to the conclusion from his observation on tuberculosis of the knee joint in children that scientific conservative treatment was preferable to excision of joints. In his recent books he adheres to the same view, and bases his opinion on the facts that there is too great a shortening following complete removal of the epiphysis and that in those cases which might respond to partial excision, cure might be obtained by the conservative method.

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4. Coote, Holmes: On Joint Diseases, London, Robert Hardwicke, 1867.

5. Koenig: Beiträge zur Resection des Kniegelenkes, Arch. f. klin. Chir. **9**:177, 1868.

6. Sayre, L. A.: Lectures on Orthopedic Surgery and Diseases of the Joints, New York, D. Appleton & Co., 1876, p. 223.

7. Thomas, H. O.: Disease of the Hip, Knee and Ankle Joints, London, H. K. Lewis, 1878, p. 168.

8. Whitman, Royal: Observations on Tuberculous Knee Joint Disease in Childhood, Arch. Pediat. **9**, 1892.

Sherman[9] (1897) came to the conclusion from his observation on operations on the knees of two children that it is possible to remove the articular cartilages of the femur and tibia and all the ossified portion of the epiphysis, and only interfere to a very limited degree with growth of those bones. He also reported at that time an operation by which he removed the entire ossified part of the epiphysis through a trephine opening over the inner tuberosity of the tibia, and another lesion in the juxta-epiphyseal region of the same bone, which was removed by a similar method.

Townsend[10] (1899) concluded from his own observation that excision of the knee joint should rarely be performed before puberty, but that erasion, arthrectomy and partial operations are to be preferred. Shortening will usually follow and will depend on the amount of bone removed and the age at which the operation is performed. Protection should be given to the knee for a long time after operation to prevent flexion deformity or genu recurvatum. The leg should always be put up straight. In septic cases amputation is to be preferred to excision.

Jones and Lovett,[11] in their recent book, state that open operation, except the excision of abscesses, should rarely be called for and never in the early stage of the disease. In acute angular flexion with external rotation and subluxation, it may be necessary in adults to perform wedge exsection, removing the joint surfaces and correcting the alinement and displacement. If this is done in young children there is danger of stopping or deviating the growth of the epiphysis and causing serious shortening.

Allison,[12] in a recent article, states that in subjects who have not gained their bone growth, but who have tuberculosis of the knee, it would seem wise to make the diagnosis early by exploratory arthrotomy, to secure the diagnosis by section of tissue removed and by guinea-pig test. In case the disease is positively found to be tuberculosis, the joint cartilage should be removed from the femur, tibia and patella, in order to secure at an early date an ankylosis with the leg in straight vertical position with the thigh, as described by Hibbs for ankylosing the knee joint in adults. He also states that the interference from this operation, in which the integrity of the epiphysis is preserved, is not greater than may occur by the conservative method with the use of crutches, plaster-

9. Sherman, Harry: Erasion of the Knee in Children with Conservation of the Epiphyseal Cartilages, South. Calif. Pract. **13**:3 (March) 1898.

10. Townsend, W. R.: The Prevention of Deformity After Excision of the Knee in Children, New York. M. J. **69**:436, 1899.

11. Jones and Lovett: Orthopedic Surgery, New York, William Wood & Co., 1923.

12. Allison, N.: The Surgery of the Knee Joint, Surg., Gynec & Obst. **39**:4 (Oct.) 1924.

of-Paris splints and braces, and the lack of function of the lower extremity throughout the growing period.

Baldwin at the Shriners' Hospital for Crippled Children, San Francisco, favors the careful resection of tuberculous knee joints in children. It was the work at this hospital that gave the impetus for the present investigation.

From this incomplete review of the literature and the writings of others not enumerated, it is found that the majority of surgeons favor the conservative treatment of joint disease in growing persons. This is especially so in the case of the knee joint, in which the adjoining epiphyses is responsible for the greatest increase in length growth. An exact determination of the disturbance in growth in the human limb following operation is rather difficult. It is necessary to exclude an existing shortening or lengthening. There also is the possibility of error in measurement due to tilting of the pelvis and the adduction or abduction of the limb. In order to get some definite data relative to interference in growth following resection of the knee joints, twelve experiments were performed on young growing rabbits. Only four of the experiments will be reported because the other animals did not survive a sufficient time to allow for any deduction.

METHOD

Under general anesthesia, with aseptic precautions, the knee joint was exposed by a curve incision below the patella. The patella ligament was severed or thrown back with a piece of the tubercle of the tibia, after which the crucial ligaments were severed and the semilunar cartilages removed with their attachments. The articular cartilage, with a thin layer of adjoining bone, was removed from the tibia, the femur and the under surface of the patella. Two shallow grooves were cut in the tibia for the reception of the condyles of the femur, and after their approximation the denuded patella was replaced. The patella tendon was sutured in place, and the wound closed in layers. A plaster dressing was applied, extending from the toes to the groin only, as it was found impractical to use a complete spica. Complete fixation was not necessary as these experiments were not intended primarily to cause an ankylosis.

PROTOCOLS

EXPERIMENT 1.—The knee joint of the right leg of Rabbit 09 was opened and the articular cartilage with a thin layer of bone was removed from both the tibia and fibula. Two grooves were prepared in the tibia for the reception of the condyles of the femur. The two approximated bones were kept in apposition by an X-suture of kangaroo tendon passed through each bone. A plaster-of-Paris dressing was applied from toes to groin. The animal died at the end of thirty-six days. There were no signs of union between the tibia and the femur.

A small osseous bridge extended from the upper surface of the tibia to the femur. The measurements of the bones were:

	Normal	Operated	Difference
Femur	5.8 cm.	5.8 cm.	0
Tibia	6.5 cm.	6.1 cm.	0.4 cm.

Thus, there had been no disturbance in growth up to this time, as any difference in length could be accounted for by the amount removed at the operation.

Fig. 1 (Experiment 2).—*A*, relative size of bones at time of operation; *B*, normal bones (comparison should be made of *A* and *B* to get normal amount of growth), and *C*, operated bones showing resected knee joint (comparison should be made with *B* to get idea of growth disturbance; total loss of growth was 1.2 cm.).

Experiment 2.—The same method was used for Rabbit 02, aged 2½ months, as in Experiment 1. The two approximated bones were held in position by a kangaroo tendon suture, passed through the tibia and femur. The experiment

was terminated at the end of 162 days. There was firm union at the site of resection. When the region of the resection was cut through, one saw an osseous bridge connecting the two bones, although it did not extend along the entire denuded surfaces. Figure 1 shows the condition that existed at the end of the experiment. The measurements of the bones were:

	Normal	Operated	Difference
Femur	9.9 cm.	9.2 cm.	0.7 cm.
Tibia	10.1 cm.	9.0 cm.	1.1 cm.

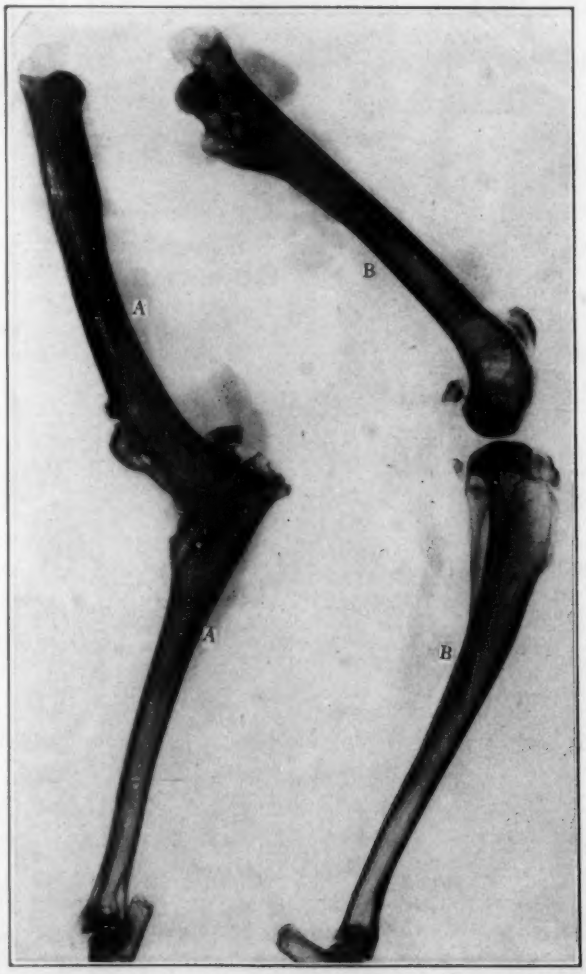

Fig. 2 (Experiment 3).—*A*, operated bones showing the resected joint in recurvation (total loss of growth was 0.4 cm.), and *B*, normal leg for comparison.

There was a total loss of 1.8 cm. on the side of the resected joint, about 0.6 cm. of which could be accounted for by removal of bone at the time of the operation.

Microscopically, the sections through the site of the resection did not show a definite continuity of bone at any one place, although it is possible that a serial

reconstruction would have established that fact. There was a large amount of new bone formed on both the denuded bones.

EXPERIMENT 3.—The same operation was performed on Rabbit 07 as in Experiment 2.

Fig. 3.—*A*, normal bones, and *B*, operated limb with resected joint; loss of growth was 2.7 cm. Greater loss in growth was possibly due to sutures injuring the epiphyseal cartilage plate.

At the end of 222 days, there was a slight amount of motion in the resected joints. Figure 2 shows a considerable amount of new bone and it is difficult to determine whether union had taken place. The measurements of the bone were:

	Normal	Operated	Difference
Femur	8.5	7.9	0.6
Tibia	9.4	9.0	0.4

Allowing for the bone that was removed at operation, there was little loss in growth due to the operation.

Microscopically, there was a large amount of new bone about the resected surfaces, although there was not a complete bony bridge connecting the two bones.

EXPERIMENT 4.—The operative procedure described in Experiment 1 was used on Rabbit 03, aged 2½ months, except that the kangaroo suture extended through the metaphysis of the tibia.

At the end of 261 days, a slight amount of posterior luxation of the tibia on the femur took place. The resected joint was stable to lateral stress but there was some anteroposterior play. A bony bridge connected the tibia and the femur at one place. Figure 2 shows the relative size of the operated and the normal bone. There appeared to be an osseous bridge connecting the two bones. There had been a retardation in growth of the two bones; of the tibia more than the femur. The measurements were:

	Normal	Operated	Difference
Femur	9.3	7.3	2.0
Tibia	10.2	8.7	1.5

If we allow 0.8 for the width of the bone and cartilage removed at operation, there still remained 2.7 cm. shortening. The total normal growth during the period was 8 cm., so there had been a retardation of about one fourth of the actual growth during the experimental period. The large amount of growth loss following this resection might have been due to the fact that the restraining suture passed through the metaphysis causing further disturbance to the actively growing cartilage cells of the epiphyseal cartilage plate. In none of the other experiments was there a loss in growth of more than 1.2 cm., which is relatively slight when it is considered that the average growth during this period was about 7 cm.

CONCLUSIONS

1. A careful resection of the knee joint, in which the entire articular cartilage and a thin layer of adjoining bone is removed, will cause practically no disturbance in length growth.

2. It is important not to injure the epiphyseal cartilage plate and to refrain from passing fixation sutures through the actively growing columns of cartilage cells.

3. It is advisable not to strip up the soft parts too near to the epiphyseal cartilage plate because of the chances of injuring its blood supply and thereby causing some growth cessation.

4. All measurements in these experiments were controlled by measuring the roentgenograms taken at a uniform target film distance. This is considered as being the most accurate means of measuring the length of bones on the living subject.

PRIMARY CONGENITAL MEGALO-URETERS*

J. S. EISENSTAEDT, M.D.
CHICAGO

Primary congenital megalo-ureter is the occurrence of enormous bilateral caliber of the ureter in cases in which there is no demonstrable obstruction to the urinary outflow as determined at necropsy or by complete examination during life. The condition has been observed in the fetus, in the new-born and in early life.

Similar cases to those reported here appear in the literature under the title of congenital dilatation of the ureters. The term dilatation is ill chosen because the so-called dilated ureters of the type to be described here probably never were of normal caliber and may represent the persistence of a stage in early fetal development. The expression dilatation of the ureters should be reserved for those cases in which there is definite pathologic condition or anomaly that accounts for the widening of the ureteral lumen. These cases may be congenital or acquired. In fact, the condition may exist in early intra-uterine life, but the cause, usually an obstruction, is determinable by thorough examination.

Several of the cases reported have been in association with and secondary to obstruction in the urethra or at the vesicle end of the ureter. Several instances were due to hypertrophy of the verumontanum. Many cases of acquired dilatation of the ureter are, of course, secondary to calculus, tuberculosis and chronic pyelocystitis. This article, however, does not concern cases having a definite or demonstrable etiologic factor.

Attention may first be called to the disturbance when complicating pathologic conditions produce subjective symptoms. No etiologic factor is determinable and the lesion may occur with other congenital defects. Complete reflux of fluid from the bladder to the renal pelves is present in full column.

CASES IN THE LITERATURE

At the seventeenth congress of the French Urological Society, Papin and Legueu [1] reported four cases of enormous dilatation of both ureters. The ureters were widely dilated from end to end and had large gaping orifices. There was no demonstrable obstruction to the urinary outflow. All four cases showed:

1. Great dilatation of both ureteric orifices, which were gaping and showed no movement of opening and closing.

2. Complete communication between the bladder and the renal pelves.

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* From the urologic service of the Michael Reese Hospital.

1. Papin: Chapter on Anomalies, Encyclopédie Française d'urologie, 1914. Papin and Legueu: Arch. urol. de la Clin. de Necker **1,** No. 4.

3. Complete filling of the urinary tree when the bladder is filled with collargol, as demonstrated by roentgenogram.

At the last meeting of the French Urological Association before the war, Hallé reported a necropsy on a girl, aged 5 years, with marked dilatation of both ureters and with no demonstrable obstruction anywhere in the urinary tract.

Couvelaire [2] reported a case of dystocia in a female fetus with a normal urethra but in which there was enormous dilatation of both ureters. John Thompson, in discussion of this case, suggested a disturbed nervous mechanism.

Saintu [3] reported a case of dystocia at 7½ months. The fetus had enormously dilated ureters, which at the narrowest portion measured from 6 to 8 mm. in diameter. There was no urethral obstruction.

Ahlfeld presented a case of a fetus with marked dilatation of the ureters and bladder without the presence of any obstruction.

Longridge [4] briefly reported two stillbirths, both girls, with no urethral obstruction but with enormous dilatation of both ureters.

At the last congress of the German Urological Association, Kielleuthner [5] reported five cases of congenital dilatation of the ureters. His report thus far has appeared only in abstract and his conclusions as to the mechanism in these cases are not stated.

Hyman [6] reported the case of a 7 year old boy with moderate hypertrophy of the bladder and enormous dilatation of both ureters. The etiology of the condition was not determined. The ureteric orifices were patulous and demonstrated complete reflux to both pelves.

Delmas, in his work on anomalies of the ureter, simply states that congenital dilatation of the ureters has been seen.

Corsy,[7] Ballantyne,[8] Böstroen,[9] Morris, Hyman [6] and others have reported cases of congenital dilatation of the ureter in the fetus and in early life associated with obstructive anomalies of the lower urinary tract. It is noteworthy that the available literature on the subject is scant and practically presents no discussion of the pathogenesis or mechanism of this rare pathologic entity.

EMBRYOLOGIC CONSIDERATIONS

The ureteral bud appears on the dorsal side of the wolffian duct in the beginning as a rather wide body. It narrows down to a uniform

2. Couvelaire: Bull. Soc. anat. de Paris **2**:287, 1900.
3. Saintu: J. de méd. de Paris **8**:332, 1896.
4. Longridge: Tr. Obst. Soc., London, **49**:215, 1907.
5. Kielleuthner: Discussion and demonstration in Ztschr. f. urol. Chir. **16**:236, 1924.
6. Hyman, A.: Internat. J. Surg. **35**:126, 1922.
7. Corsy, F.: J. d'Urol., 1921, p. 185.
8. Ballantyne: Antenatal Pathology, 1902.
9. Böstroen: Beit zur pathologischen Anatomie-der Neiren, Freiburg, 1884.

caliber by the end of the second month, at which time it is without musculature. Muscle fibers appear next to the bladder at the beginning of the third month and gradually extend upward until they are present at the level of the renal pelvis, about the middle of the fourth month.

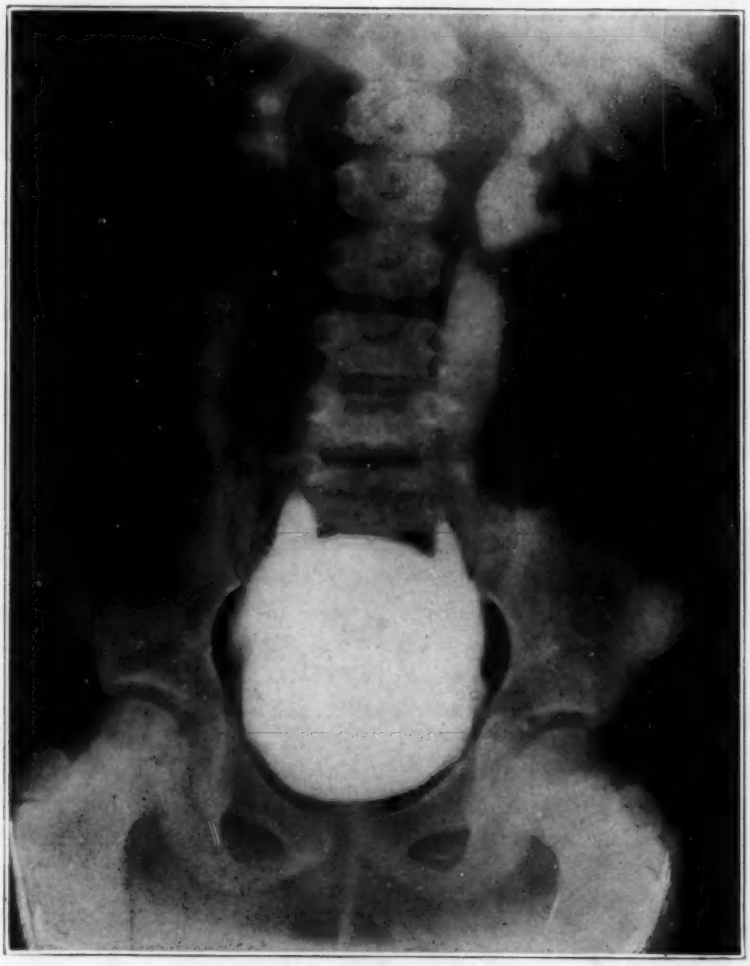

Fig. 1 (case 2).—Urinary tract filled with sodium iodide solution; enormous size of bladder and both ureters, with complete reflux to both renal pelves, should be noted.

Gerard,[10] working under Papin's direction, found that the ureter in fetuses up to the fourth or fifth month is of enormous caliber as compared with the kidney and the rest of the body. He states that it can readily be supposed that the organ instead of diminishing in caliber from

10. Gerard: These de Paris.

this period, as is normal, can continue to develop concurrently with the rest of the body and remain, even in adult life, as voluminous in caliber as it is in early fetal life.

Lorain,[11] in his thesis on dilatation of the ureter, states that this type of ureteral dilatation may represent the norm in "the first stage of embryonal life (Au premier stade de la vie embryonnaire)," and that it is not surprising that a certain number of dilatations of the ureter should be of congenital origin, because the urinary system affords not uncommonly many abnormalities, from a mild hypospadias to those that are incompatible with life itself.

I have found a wide caliber of the ureter in the earliest weeks of fetal life but no uniformity of this characteristic after the tenth or eleventh week. Some of the ureters examined at this stage have been wider than others. This observation has also been noted by Kampmeier [12] in the pelves and calices in a few early fetal kidneys which he examined while doing his excellent work on "Origin of Congenital Renal Cysts." The subject considered here was not of interest to him at the time of his research and he does not have any statistical data as to the frequency of the wide pelvis and major calices.

REPORT OF CASES

History.—The two cases of primary congenital megalo-ureters which I have observed both occurred in little girls. Patient 1 was 5 years old when first observed; patient 2 was 7½. Both entered the service of Dr. I. A. Abt at the Sarah Morris Hospital for Children. Because of the practically identical nature of the histories, symptoms and conditions observed, I shall report the cases together.

Both girls entered the hospital with the history of dysuria and increased frequency of urination since earliest childhood. The urines of both were turbid and contained many leukocytes and bacteria. Colon bacilli and staphylococci were present in the urines, the former predominating. The general condition of the younger child, patient 1, was obviously poorer than that of the elder. The temperature variations were greater in the younger child. At the time of the first examination both were able to make daily use of the playroom.

The younger child died and we have a complete report of the necropsy findings of the intra-abdominal viscera. The elder child is alive and to date in excellent condition except for the pathologic condition of the urinary tract.

The general physical examination was negative except that the younger child had a prominent abdomen. This had been noted intermittently since her third year.

Cystoscopic Examination.—Cystoscopic examinations also were practically identical. There was no obstruction or pain on the passage of the cystoscope. There was no obstruction in the urethra as determined by olive tipped bougies. The bladder contents were moderately turbid, the bladder tolerance good or increased. Both children required repeated washings of the bladder to obtain a medium clear enough for accurate observation.

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11. Lorain, A.: Thèse de Paris **30,** 1921.
12. Kampmeier: Personal communication to the author.

A slight to moderate grade of cystitis with indistinct vascular markings, especially in and about the trigonum, was found in each case. Practically the entire mucosae were involved to lesser degree. A moderate degree of trabeculization was noted, of mixed type rather than of the distinctly coarse variety. At the usual location of the ureteric orifices huge openings were seen symmetrically placed; in the first instance these were thought to be the openings of diverticula. They proved, however, to be the very wide gaping, rigid ureteric orifices. They averaged from at least 1.5 to 1.6 cm. in diameter and did not contract or show the slightest movement on repeated examination. The internal urethral orifices were negative.

Cystograms taken to demonstrate the size and location of the suspected diverticula revealed some enlargement of the bladder and a complete filling of the urinary tree to the pelvis of both kidneys. There was no demarcation between bladder content and ureteric content and the ureters were seen to be

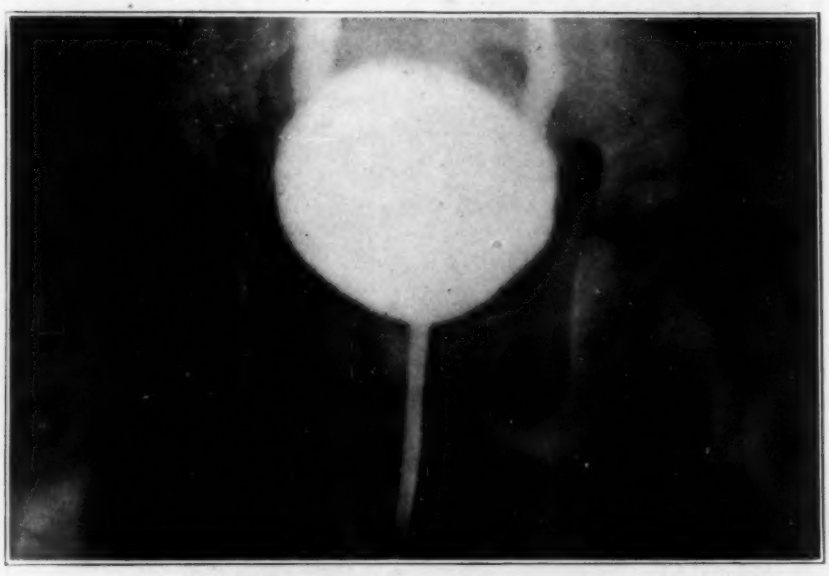

Fig. 2 (case 1).—Enormous bladder.

many times their normal diameter and apparently much too long for the torsos of the children. The hips of the children were not elevated when roentgenograms were made.

Postmortem Examination.—The postmortem examination[13] of patient 1 by Dr. David B. Witt yielded the following anatomic diagnosis: bilateral dilatation of the ureters; bilateral pyonephrosis; hypertrophy of the bladder; chronic interstitial nephritis and acute splenitis.

The kidneys, ureters and bladder were removed together. The right kidney measured 7.8 by 4.5 by 2.7 cm.; the left 8 by 4.5 by 2.2 cm. The capsule of each was adherent and removed with difficulty. The ureters were greatly dilated, the right more than the left. The latter was 0.9 cm. in diameter at its midportion and

13. In this report the word dilatation is the pathologist's, and while it is in common use referring to this condition, is a misused term in this connection.

1.2 cm. in diameter in its lower third. The right ureter was 1.5 cm. in its upper third, 1.9 cm. in its middle third, and 0.9 cm. in its lower third. On section of the kidneys and ureters, the pelves and calices were found to be greatly dilated and filled with cloudy, purulent fluid. The medulla of each kidney had largely disappeared through the dilatation, the calices being covered by a layer of kidney tissue averaging 1 cm. in thickness. The ureters also were filled with purulent

Fig. 3 (Koll's case).—Bilateral megalo-ureters with two ureters on right side.

fluid. Their inner surface was pale and smooth. At the ureteropelvic junction of each kidney were several horizontal folds, but these did not encroach on the lumen sufficiently to offer hindrance to the flow of urine. Two centimeters below this region the wall of the right ureter contained a hard, almost cartilaginous area which was poorly defined. At their lower ends the ureters opened into the bladder by wide mouths which offered no obstruction. The bladder was contracted and contained a small amount of cloudy fluid. It measured 7 by 5 by 4 cm.;

the wall was from 0.5 to 1 cm. thick. The inner surface was trabeculated and had a number of small hyperemic areas. The urethra was patent and offered no obstruction to the passage of a large probe. From the gross examination the dilatation of the ureters, the pelves and the calices appeared to be secondary to the condition that had led to the hypertrophy and trabeculation of the bladder. However, no mechanical obstruction to the outflow from the bladder could be seen.

Microscopically, the pelvic epithelium was found to be absent in areas of considerable extent. The surface of such areas was covered by a mass of leukocytes. A rather broad zone of medullary tissue next to the surface was cellular; it contained lymphocytes, leukocytes and fibroblasts, the tubules being widely separated in this tissue. The medulla was diffusely fibrous; scattered throughout the fibrous tissue were moderate numbers of lymphocytes, plasma cells and eosinophils. The medulla contained only a few tubules of normal size; these were filled with pus cells. Minute, almost completely atrophied tubules were numerous. In the cortex there had also been widespread replacement and atrophy of the tubules by cellular stroma that was infiltrated by round cells. Tubules of nearly normal size were few in number and occurred in widely separated groups; their epithelium was low and their lumens were filled with leukocytes. A few glomeruli had been atrophied, but on the whole the slight involvement of the glomeruli, as compared with the tubules, was striking. The tufts appeared normal in such glomeruli; the capsule was slightly thickened by the surrounding interstitial fibrosis. In one area some of the glomeruli were granular and necrotic and the tubules distended by granular material. Scattered about in the proliferated interstitial tissue were islands of dense lymphoid infiltration. The striking feature of the kidney was the disappearance of secreting tubular parenchyma within the cortex.

The wall of the left ureter was moderately thickened and in general densely fibrous. Surface epithelium was absent. A thin inner zone was cellular, being densely infiltrated by lymphocytes, intermingled with which were a few fibroblasts. Narrow bands and larger islands of lymphoid infiltration separated some of the bands of the deeper tissue. Several islands of dense lymphoid infiltration were present in the periureteral fat. In the right ureter the increase in thickness of the wall was due to the formation of a thick layer of dense fibrous tissue outside the outer muscle coat. Muscle tissue was not increased, but rather partly atrophied; its bundles were separated by bands of round cell infiltration.

The lining epithelium of the bladder was absent except in a few cryptlike folds that dip down for a slight distance into the tissue. A thin superficial zone was richly infiltrated by lymphocytes and plasma cells and contained a few leukocytes and eosinophils. The wall contained smooth muscle, the muscle increase involving both the inner and the outer coats. Just beneath the cellular inner zone were numerous small calcium masses.

As revealed in the accompanying illustrations the bladders were rather large and well filled; the ureters were enormously and about equally dilated. The ureters were apparently too long for the torso and sausage-like segments were apparent. Furthermore, at no place in the entire ureter did its diameter even approach the normal caliber. The renal pelves and calices were also seen to be markedly dilated. There was absolutely no evidence of any organic obstruction on examination nor was any found in the child examined postmortem. Whether or not an obstruction existed in fetal life not determinable at the time of examination or necropsy is another question. Torsions or folds in the ureter are noted, however, in about 20 per cent of new-born children.

The chief characteristics of the cystogram of primary congenital megalo-ureter which differentiate it from the acquired type and the congenital type due to obstructive processes are:

1. The bladder is enlarged and shows increased capacity.

Fig. 4 (Lorain's case).—Drawing made from roentgenogram.

2. There is no evidence of obstruction in any part of the tract due to any mechanical condition, such as stone, valve or stricture of the ureter or urethra.

3. The filling of the ureteral trees is bilateral, complete and symmetrical and practically equal on both sides, and reflux is complete without any pressure other than that of the filled bladder.

4. There is no demonstrable demarcation between the filling fluid in the bladder and that in the ureters.

I have seen a number of dilatations of the ureter resulting from such well understood etiologic conditions as stone, tuberculosis, prolonged pyelocystitis and various lesions of the spinal cord; no case studied, however, has presented all the characteristics that have been enumerated.

THEORETICAL CONSIDERATIONS

In the absence of any determinable obstructive cause the mechanism of congenital megalo-ureters may involve:

1. Deficient development in the musculature of the ureter. The musculature of the ureter does not begin to develop until the beginning of the third month and does not reach the renal pelvis until the middle

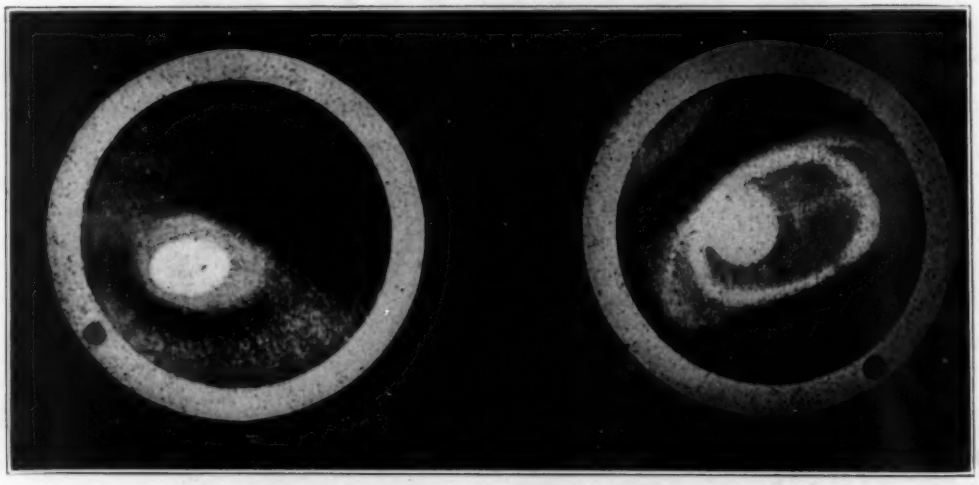

Fig. 5 (Legueu and Papin's case).—Appearance of ureteric orifices.

of the fourth month. The possibility of an imperfect development of the muscle fibers, a true hypoplasia, must be seriously considered. This likelihood plus the persistence of the wide caliber of the ureters, as in early fetal life, might explain the mechanism of the condition.

2. An inhibitory influence on the growth of the ureter, as Girard suggests, should manifest itself during the fifth and the sixth intrauterine month. This may not exert its influence and the ureter continue to grow in length and caliber at a time when it should cease to do so. Were this the cause, however, one would expect the tissues of the enlarged ureters to be normal as observed microscopically.

3. The ureter, like the renal pelvis and the major calices, as noted by Kampmeier, may be very wide in certain fetuses. This is merely another way of saying that no cause can be found in certain cases.

4. In early intra-uterine life some obstruction may exist, probably at the bladder outlet, which is later not demonstrable.

5. A disturbed or deficient nervous mechanism, as Thompson suggested in discussing Couvelaire's case, may be at fault. This point of view cannot be disregarded, because the resemblance of the ureteric

Fig. 6 (Gaudino's [14] case).—Drawing made from roentgenogram.

orifices to those seen in patients suffering from certain cord lesions was striking and the reflux of fluids from the bladder to the renal pelves was similar. The trabeculation noted in the bladders of both children likewise simulated, though not perfectly, the type seen in some patients

14. Gaudino: Semana méd. **2**:329-336 (Aug. 17) 1922.

suffering from cord lesions. And this I interpret as a labor hypertrophy due to the shortening of the intervals of bladder contraction. I have never seen any patient with spinal cord disease show such bilaterally wide orifices and such excessive caliber of the ureters. The spinal cord of the child who died, unfortunately, we were not permitted to remove for examination, but during life she showed no evidence whatsoever of a cord lesion. Patient 2, still living, likewise does not show any symptoms referable to the nervous system.

The necropsy findings of inflammatory round cell infiltration and atrophy of the muscle fibers might suggest that the large caliber of the ureters and the huge rigid orifices were secondary to a long continued inflammatory process, but the presence of identical findings in the fetus and in still-born children would lead one to believe that the wide caliber of the ureters and their huge orifices were primary conditions and not due to an inflammatory process.

SUMMARY

1. Congenital bilateral megalo-ureter may occur without demonstrable cause and, hence, is called primary.

2. The cysto-ureterograms and cystoscopic findings are characteristic, as observed in the two cases reported here.

3. The mechanism underlying the development of this condition may be explained by embrologic considerations, probably a deficiency in the development of the musculature of the ureters.

SARCOMA OF THE STOMACH*

CHARLES E. FARR, M.D.
NEW YORK

Sarcoma as opposed to carcinoma ranks low in the tumors of the gastric wall. Various percentages are given in the different clinics; it remains well under 5 per cent of the malignant conditions. Just why this is so is hard to understand unless we take into consideration the great amount of epithelial surface exposed to constant chemical and mechanical assault. The connective tissue elements are much less in relative amount and are little exposed to injury of any sort. In this respect the relative frequency of sarcoma and carcinoma of the stomach is comparable to the corresponding tumors of the uterus.

As to the etiology of sarcoma, here as elsewhere nothing is known; the point of origin is usually the musculature but may be any of the connective tissue elements of the organ. The diagnosis is rarely made. At most a tentative diagnosis of malignant tumor can be entertained. The outstanding feature of a large number of cases is the symptomless development up to a certain stage, followed by rather pronounced symptoms suggestive of ulcer, even of perforation.

The treatment of sarcoma of the stomach is as yet purely surgical, consisting of wide resection, pylorectomy, and, rarely, a palliative gastroenterostomy.

The literature of this rather rare affection has been thoroughly worked up by the Mayos and more especially by Dr. John Douglas.

The following two cases seem worthy of report because the disease is still a rare one and because two widely different types of sarcoma are present—one closely resembling the typical calloused ulcer, or early carcinoma, the other being more like a mild acute pancreatitis—and because both patients recovered from operation. Curiously enough, the patient with the more malignant type is still well and without symptoms nearly three years after operation, while the other, with an apparently milder type, suffered a recurrence and died within two years.

REPORT OF CASES

CASE 1.—A man, aged 34, born in the United States, entered the New York Hospital, April 26, 1920, in the service of Dr. Charles L. Gibson. He weighed 120½ pounds (55.6 Kg.). He was discharged, May 11, weighing 112 pounds (50.8 Kg.). His complaint on entering was pain in the epigastrium. The present condition was that for five or six months he had had pain in the epigastrium one-half to one hour after meals, with gas and sour eructations, gnawing and burning; these were relieved by soda or vomiting and made worse by food. The pain was

* From the first surgical (Cornell) division of the New York Hospital.

rather high and along both costal margins. There was a tender spot just to the right of the midline halfway from the ensiform to the umbilicus. The symptoms were relieved by a meat free light diet, and entirely relieved by a milk diet and soda; they returned at once on resumption of solid food.

Before the onset of symptoms there had been marked constipation for two months, but the bowels had been regular of late. There was a severe vomiting spell two weeks before the patient entered the hospital, followed by a black stool for two days. There was no blood in the vomitus. He had lost 20 pounds (9 Kg.).

The past history was negative as to previous similar attacks. He had had no operations. There was no polyuria, no dysuria, no serious illness of any sort. The family history was negative.

The physical examination showed a fairly well developed and well nourished young adult who did not appear acutely ill. There were no abnormal findings in the head, neck or chest. The abdomen was flat, almost scaphoid, and symmetrical. There was slight tenderness in the umbilical and epigastric regions. No mass could be felt; the extremities were negative. The liver, spleen and kidneys were not felt.

A provisional diagnosis of gastric ulcer was made. The temperature, pulse and respiration were normal. Gastric analysis of 30 cc. of greenish brown fluid showed a moderate amount of mucus, free hydrochloric acid 68, total 90. The guaiac reaction was positive. Microscopically, there were some red blood cells, mucus and food remnants. A fractional Ewald test was performed, running 20-70 free, 35-90 total at one hour and fifteen minutes. It is interesting that the post-operative fractional Ewald test ran 0-5 for free acid, and 5-21 for total acidity.

A pylorectomy for sarcoma was performed by Dr. Gibson, April 28, under ether; it took one hour and forty-five minutes. The condition was fair; the pulse ran from 80 to 130 at the end of the operation. A high right rectus incision was made; an indurated, irregular mass the size of the palm of the hand was found on the posterior surface of the stomach adjacent to but not impinging on the pylorus. An obviously enlarged lymph node was found just above and another just below. No other metastases were seen or felt. The stomach was not adherent.

Resection of the distal one third of the stomach and closure of both stumps with a Payr clamp and cautery, reinforced by two rows of sutures was the procedure used. Posteriorly, a no loop gastro-enterostomy was performed, using tongue depressor clamps and five rows of suture, three posterior, the first and last silk, the others chromic catgut.

Microscopic examination showed sarcoma of the stomach, which was ulcerated. The specimen consisted of a resected portion of the stomach, the seat of an ulcer 5 cm. in diameter; the edges were overhanging. The ulcer was shallow and had a thick base, measuring 1 cm. The base consisted of a layer of homogeneous soft white tissue, 1 cm. thick. Outside this was a layer of denser connective tissue. Microscopically, the base of the ulcer consisted of a new growth composed of large polyhedral and round cells resembling a sarcoma. It did not infiltrate the muscle coats. The surface was ulcerated. A small lymph node showed no involvement. A later report stated that there was a dense collection of darkly nucleated cells and medium size round cells between the mucosa and the muscular coats of the stomach. This collection was not sharply circumscribed but tended to invade the muscularis mucosae and the muscularis. There were some mitotic figures present and the cells were neoplastic. The mucosa of the stomach was normal. The appearance was that of a lymphosarcoma. This diagnosis was confirmed by Dr. James Ewing.

The postoperative course was uneventful. The usual postoperative treatment of ice cap and rectal drip was instituted, and nothing was given by mouth for twenty-four hours. There was some vomiting up to May 1; this was relieved by lavage. The wound healed by primary union.

The follow-up notes were as follows: November 3, the patient had some gas after food; he had gained 24 pounds (10.9 Kg.). Jan. 9, 1922, he felt absolutely all right; his weight was 133 pounds (60.3 Kg.). Jan. 2, 1923, he felt absolutely all right; his weight was 141 pounds (64 Kg.); he ate everything in limited quantity.

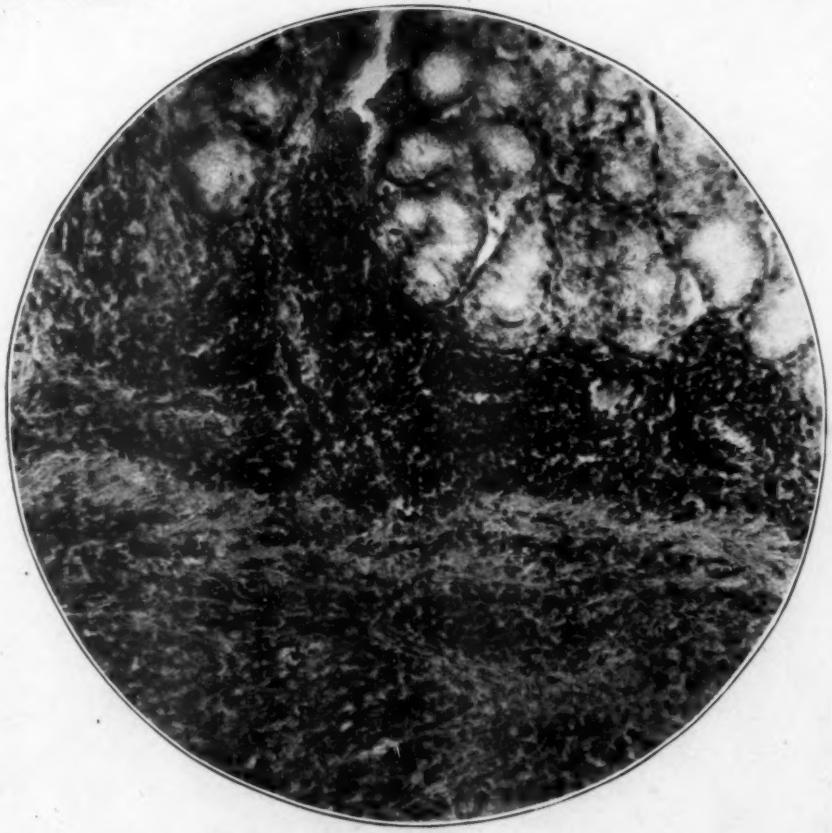

Fig. 1 (Case 1).—Sarcoma of stomach.

CASE 2.—A man, aged 28, Jewish, entered the hospital July 5, 1921, and was discharged August 15. He complained on admission of pain in the epigastrium and difficulty of breathing of twenty-four hours' duration. July 4, in the morning he was taken with a sudden onset of pain in the epigastrium to the left of the midline under the costal margin. He also noticed that it was hard for him to get his breath. He couldn't get the air in. The pain was not sharp and did not radiate. There was no pain in the back, no indigestion and no jaundice. The bowels were constipated. He insisted that up to July 4 he had been in perfect health in every way. His past history was negative. He had never been sick before, and had no digestive disturbances but suffered from habitual constipation.

The family history was irrelevant. He had never had venereal disease nor any nervous symptoms.

Physical examination showed a well developed, well nourished man lying quietly in bed. The head, neck and thorax were negative. The abdomen showed moderate tenderness and rigidity in the upper portion, mainly to the left. The spleen, liver and kidneys were not felt. The extremities and the lymphatics were normal. The urine showed a faint trace of albumin and a few leukocytes. The temperature was 103, pulse 102, respirations 24.

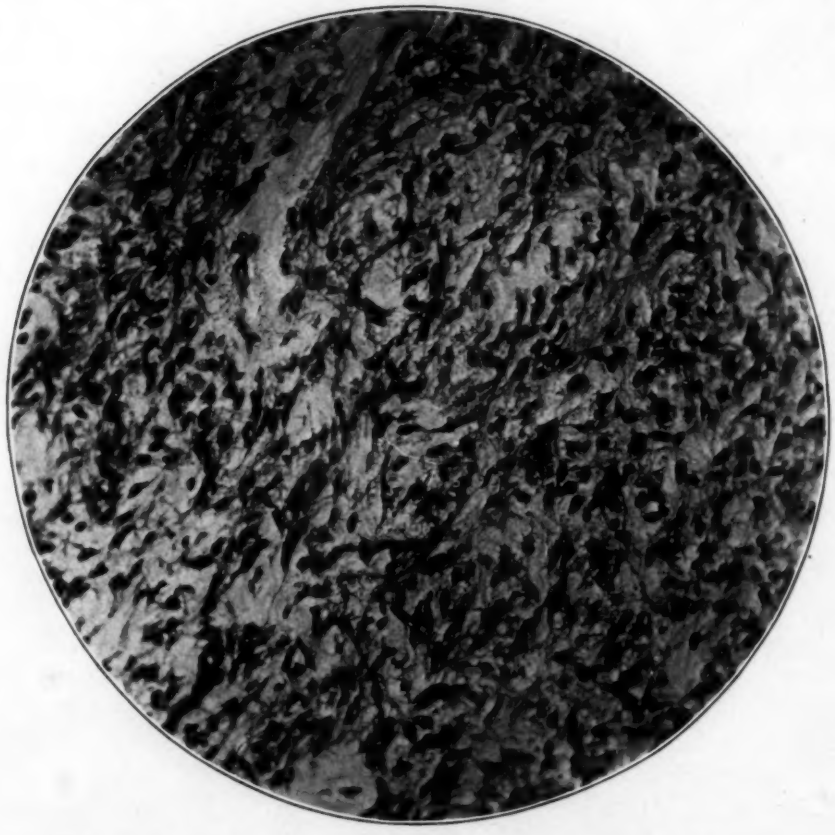

Fig. 2.—Perforating sarcoma of stomach in which resection was done.

The tentative diagnosis by the medical staff was perforating gastric ulcer; by the surgical staff, acute pancreatitis.

July 6, I operated, making a right rectus incision with an additional transverse cut. There was a perforating sarcoma of the stomach 10 cm. in diameter about two thirds of the way to the cardia on the anterior surface near the lesser curvature. It was pedunculated, round, bluish and apparently vascular. It was covered with omentum and there was a slight deposit of fibrin. When the omentum was lifted the mass tore partly loose, leaving a 2 cm. perforation in the stomach wall. There was no bleeding of any moment. The condition was deemed inoperable from the standpoint of radical cure and a wide excision was

done, about two thirds of the anterior wall of the stomach being removed. A plastic suture was then carried out to prevent hour-glass formation, using two layers of chromic catgut. A cigaret drain was placed; closure was in layers with silkwormgut. A hasty examination of the liver and spleen, omentum and nodes showed no apparent metastases.

The time was forty-five minutes. The postoperative pulse was 92; the general condition was satisfactory. Recovery was uneventful except for the free sloughing of a portion of the abdominal wall. He went home on the thirty-ninth day in fair condition, with a fair appetite.

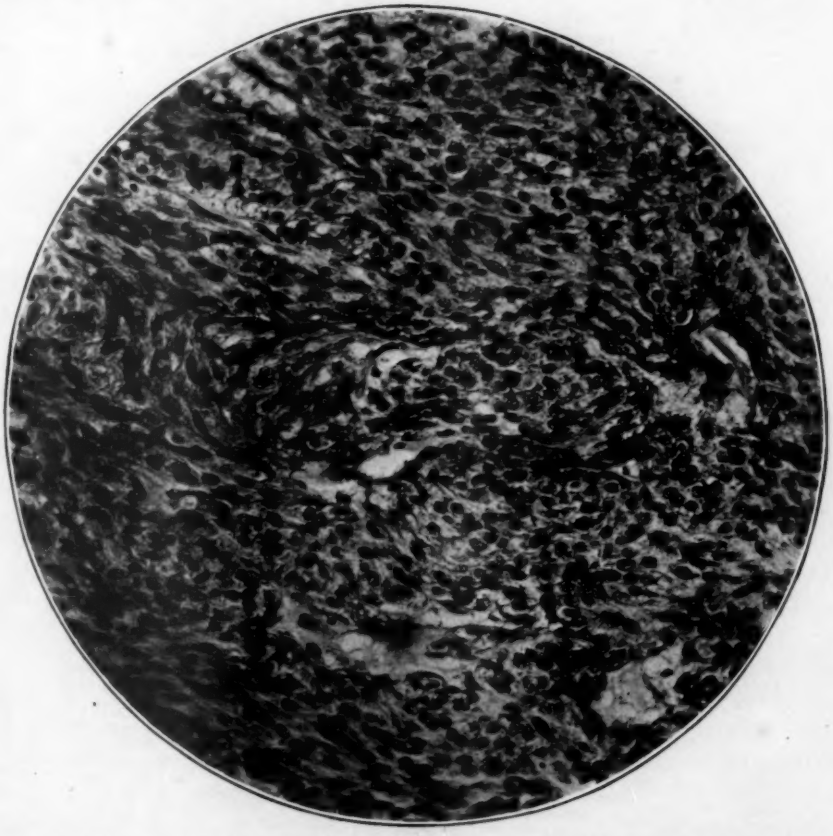

Fig. 3 (Case 2).—Perforating sarcoma of stomach in which resection was done.

The pathologist's report was that the tumor had a grayish white medullary appearance. Frozen sections showed a very cellular, actively growing tumor having the structure of a sarcoma.

Paraffin sections from various parts confirmed the previous diagnosis. The portion of the growth attached to the stomach had completely replaced the wall of the organ up to but not involving the mucosa or the muscularis mucosae. The margin of the tumor at this point was fairly sharply defined. The mucosa covering it showed the lesions of a chronic gastritis.

The tumor proper varied in appearance in different sections. In places it was very cellular, composed of spindle cells with large nuclei containing several

nucleoli, and resembling large nonstriated muscle fibers, though the cell bodies lacked the acidophilic properties of the latter. The cells showed numerous mitotic figures. In other regions the spindle cells were less numerous and were separated by areas of edematous tissue or large areas composed of a homogeneous material staining faintly with hematoxylin.

The follow-up reports were: October 8, the patient had gained 16 pounds (7.3 Kg.). He ate well, slept well, and had slight pain. November 19, the scar was firm; no tumor was felt, and the general condition was good. April 8, 1922, the patient, who had weighed 180 pounds (81.6 Kg.) at his best, now weighed 160 (72.6 Kg.). He ate everything and was working; no masses were felt. The wound bulged a little but there was no hernia. In June, 1922, there was a massive recurrence, which was hopeless. He was referred to the roentgen-ray department, Sept. 8, 1922, and given treatment at the Memorial Hospital. He died in January, 1923.

Deep roentgen-ray therapy was instituted on this man after the operation. He had a rather disagreeable reaction and refused to continue it.

CONCLUSIONS

Of the two cases of sarcoma of the stomach presented here, one, of the round cell type near the pylorus, closely resembled in its clinical aspects a calloused ulcer; the other, of the spindle cell type growing apparently from the musculature of the anterior wall of the stomach near the cardia, gave no clinical symptoms whatever until the day before operation. The patient with the round cell sarcoma who had a pylorectomy performed has made an apparently complete recovery and should be cured. The patient with the spindle cell tumor, whose operation was necessarily incomplete, relapsed after a year and died in less than two. On the whole the outlook in sarcoma of the stomach is fully as good as it is for carcinoma. If the diagnosis could be made earlier, the results, as in carcinoma, would probably be quite reasonably good.

PARTIAL TRACHEAL OBSTRUCTION

AN EXPERIMENTAL STUDY IN THE EFFECTS ON THE CIRCULATION AND RESPIRATION OF MORPHINIZED DOGS *

ALFRED BLALOCK, M.D.
TINSLEY RANDOLPH HARRISON, M.D.
NASHVILLE, TENN.
AND
CHARLES P. WILSON, M.D.
BOSTON

In the course of some observations on the blood gases in asthma,[1] certain findings indicated significant changes in the circulatory mechanism. Recently there has been an opportunity to make similar studies on two patients with acute laryngeal edema and interesting changes were found in the blood gases and blood reaction. Though the clinical studies have been temporarily abandoned because of a lack of material, the findings in asthma and acute laryngeal edema led to a series of controlled observations on experimental respiratory obstruction in dogs.

The problem was to study the effects of partial tracheal obstruction on the blood gases, blood reaction and volume flow. The object of the present article is to report the results of these experiments.

METHOD

Since asthma is difficult to produce in dogs and the experimental production of laryngeal edema is unsatisfactory, the following technic was employed to produce tracheal obstruction:

Dogs of from 6 to 14 kg. were used. The animals were given 0.06 gm. of morphin subcutaneously. Forty minutes to one hour later, tracheotomy was performed, local anesthesia being used when necessary. The carotid artery and the femoral vessels were exposed. A large metal cannula was inserted into the trachea and firmly tied so as to make an air tight connection. From the tracheal cannula a short rubber tube led to the mouthpiece of a Benedict spirometer filled with oxygen. The oxygen consumption was measured by the graphic method as described by Roth,[2] the Collins chronokymograph being used to record time on the

* From the departments of surgery, medicine and pathology of the Johns Hopkins University Medical Department.

1. Harrison, T. R., and Boyd, D.: Observations on the Blood Gases in Asthma, unpublished.

2. Roth, P.: Modifications of Apparatus and Improved Technique Adaptable to the Benedict Type of Respiration Apparatus, Boston M. & S. J. **186**: 457 (April 6) 1923.

curve. By this method it was possible to obtain a constant oxygen consumption (Fig. 1) and at the same time a graphic record of the respiration.

After the animal had breathed quietly for about fifteen minutes, in order to insure a constant rate of oxygen consumption, blood samples were taken. Simultaneous samples of blood were withdrawn under oil from the right ventricle and the right femoral artery. At the same time a third observer drew blood from the left carotid artery into a tuberculin syringe for hydrogen ion determination. When the first observer experienced difficulty in puncturing the right ventricle, as was occasionally the case, the other two observers waited until venous blood appeared in the syringe before withdrawing arterial blood. In this way the three samples were obtained simultaneously. The pulse was counted before and after the punctures.

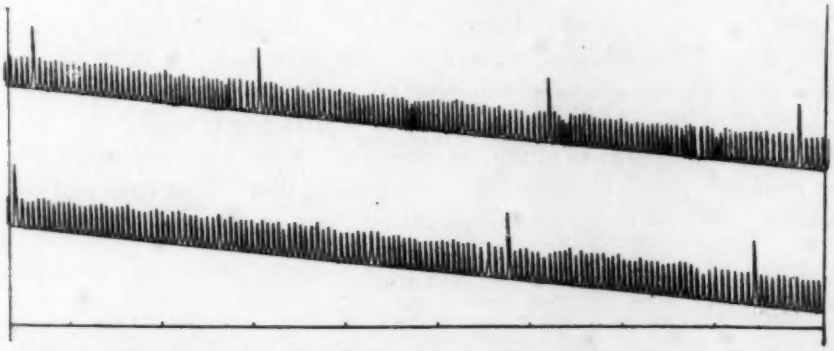

Fig. 1.—Normal respirations with even oxygen consumption. The curve passes from right to left. The rise in the curve indicates oxygen consumption. The tracing shows that the rate of rise is constant. The evenness of the respirations is noteworthy.

A small metal screw clamp was then placed over the rubber tube leading from the tracheal cannula to the mouthpiece of the Benedict apparatus. By turning the screw the tube could be constricted to any desired degree. In some experiments the effects of slight degrees of constriction were noted; in others the effects of greater constriction were observed. The degree of constriction could be measured by the degree of slowing of the respiratory rate and the curtailment of the respiratory excursion as seen on the kymographic record (Fig. 2).

Five or ten minutes after the respirations had reached a constant rate and depth, a second series of samples was drawn. The constriction was then released; and from thirty to sixty minutes later, when the animal had returned to normal, a third set of samples was taken.

At the end of each experiment the animal was killed with ether or chloroform and a necropsy was performed. The heart chambers were examined in order to make sure that the needle had not passed through the septum into the left ventricle, which would have resulted in mixing arterial and venous blood. The one experiment in which such a septum puncture was found was discarded in toto. The lungs also were examined. In one animal (Dog 8) which reacted in an entirely different manner from the others, a condition of pneumonic consolidation with

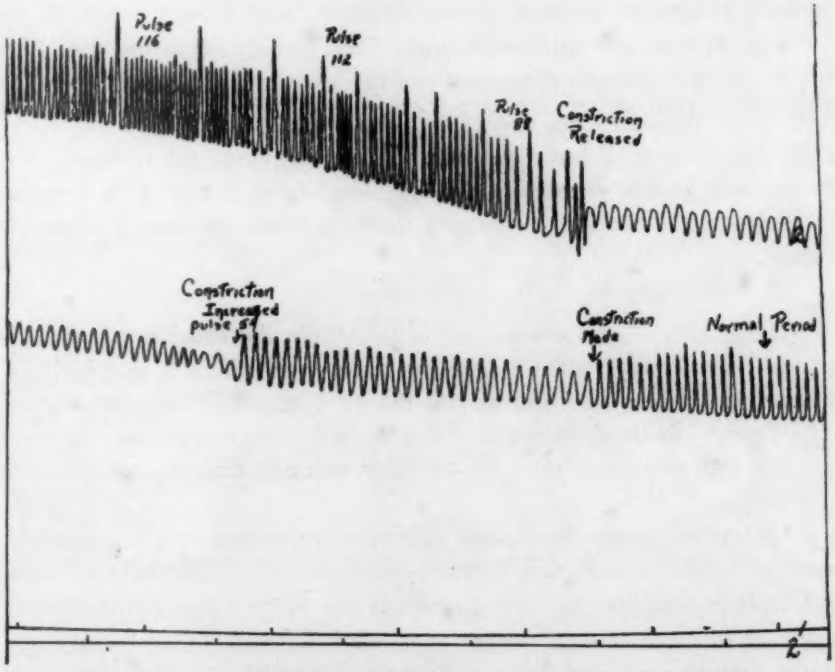

Fig. 2.—Effects of constriction on respiration and oxygen consumption. The curve passes from right to left. The effects of constriction and release on the respiratory rate and depth are striking. The oxygen consumption rate of rise of the curve is relatively constant.

pulmonary edema was found. In the other animals the lungs were normal except for hypostatic congestion and an occasional subpleural hemorrhage, which were due, we believe, to the asphyxial death.

The arterial and venous carbon dioxid and oxygen contents were determined by the method of Van Slyke and Stadie [3] with the Van Slyke long bore constant pressure apparatus. The hydrogen ion concentra-

3. Van Slyke, D. D., and Stadie, W. C.: The Determination of the Gases of the Blood, J. Biol. Chem. **49**:1 (Nov.) 1921.

tions were determined according to Hawkins' [4] modification of Cullen's [5] colorimetric method. A tuberculin syringe was used to measure the blood. Because of the nature of the experiments, these determinations had to be done hurriedly and a greater accuracy than $p_H \pm 0.03$ is not assumed. The changes encountered were always greater than these limits of error. In interpreting the results more emphasis has been laid on changes in p_H than on the actual p_H values. Since the Sorenson phenol red standards which were used are only satisfactory within the corrected range, p_H 6.90 to p_H 7.60, our more acid values are indicated in the tables by 6.90 —, and our greatest alkaline values by p_H 7.60 +.

The circulatory minute volume was calculated from the Fick principle: $\frac{\text{C.c. oxygen consumed per minute}}{\text{Amount of oxygen taken up by 1 c.c. of blood}} =$ number of cubic centimeters of blood flowing through the lungs per minute. The respiratory minute ventilation was calculated by multiplying the respiratory rate by the average respiratory depth as shown on the kymographic record.

RESULTS

The results of constriction were essentially the same in all animals except one. It was noted before the experiment that this dog had distemper and subsequent necropsy showed a bilateral bronchopneumonia. The figures obtained during the resting and constriction periods were entirely different from those in all other animals, and are not given in this article.

The values in the charts and tables for pulse and respiration rates, minute ventilation and oxygen consumption do not include those throughout each period, but only the figures at the times when blood samples were drawn.

Before Constriction.—The pulse rate was quite slow in all the animals, the average being less than 60 per minute. Cardiac irregularities were not observed in any case. The respirations were uniform in character in most instances, with the normal pause between inspiration and expiration. The respiratory rates ranged from 16 to 64 per minute, the high figure occurring in a large dog in which the respiratory center was stimulated rather than depressed by the morphin. The oxygen consumption varied almost directly with the weight of the animal under

4. Hawkins, J. W.: A Micromethod for the Determination of Hydrogen Ion Concentration in Whole Blood, J. Biol. Chem. **57**:493 (Sept.) 1923.

5. Cullen, G. E.: Studies in Acidosis, XIX, The Colorimetric Determination of the Hydrogen Ion Concentration of the Blood Plasma, J. Biol. Chem. **52**:501 (June) 1922.

observation and proceeded at a regular rate during the control period. The differences between arterial and venous oxygen and between venous and arterial carbon dioxid were within normal limits in all instances. The hydrogen ion concentration was less than 7.32 in every case owing to the fact that morphin produces a slight acidosis. The minute ventilation and the volume flow varied almost directly with the weight and as the pulse rates were quite uniform, the output per beat varied likewise.

Moderate Constriction.—When moderate constriction of the trachea was made, the following changes occurred in pulse rate, respiratory rate, oxygen consumption, blood gases, blood reaction and volume flow: The pulse rate increased slightly and the respirations were slowed and more labored. The animals used all the accessory muscles of respiration but did not open their mouths in gasping for breath, as did those with more

TABLE 1.—*Effects of Moderate Tracheal Obstruction (Average Figures for Five Experiments)* *

Average weight of animals, 9.2 kg.

	Pulse Rate	Respiration Rate	Oxygen Consumption per Minute, C.c.	Arterial Oxygen, per Cent. by Volume	Venous Oxygen, per Cent. by Volume	Venous CO_2, per Cent. by Volume	Arterial CO_2, per Cent. by Volume	p_H	Volume Flow, Liters	Output per Beat, C.c.
Before constriction	56	22	55.4	20.6	15.5	47.3	42.6	7.27	1.21	20.6
During moderate tracheal constriction	75	15	66.9	21.2	17.3	52.2	50.0	7.13	1.88	29.4
Following release of constriction	72	24	75.5	20.9	15.3	47.6	40.5	7.25	1.28	20.8

* In some of the experiments, all the functions listed were not determined. The figures in the table represent averages for the experiments in which determinations were made.

severe constriction. They did not struggle in any instance. The oxygen consumption increased despite the fact that the respirations were slow and shallow. This is shown in Figure 2. The rise in oxygen consumption seemed to be in proportion to the increased respiratory effort. The arterial oxygen was slightly higher with moderate constriction than during the control period. Anoxemia did not occur with this type of obstruction. There was a slight increase in the carbon dioxid content of both the arterial and the venous blood. The blood became more acid and the volume flow increased. The average figures giving the effects of the production of moderate tracheal obstruction in five animals are given in Table 1 and the effects on the respirations and oxygen consumption are shown in Figure 2.

Severe Constriction.—With severe constriction the following changes took place: The respirations became much more labored; the respiratory rate was slowed, and the respirations became shallower for the muscles of expiration did not seem able to empty the lungs completely. The

oxygen consumption was increased in all instances. The oxygen content of the arterial and venous blood tended to equalize and the carbon dioxid content was greatly increased. Whereas the arterial oxygen rose slightly with moderate constriction, there was a marked fall with severe constriction. The effects of severe constriction on the hydrogen ion concentration and blood flow were similar to those produced by moderate

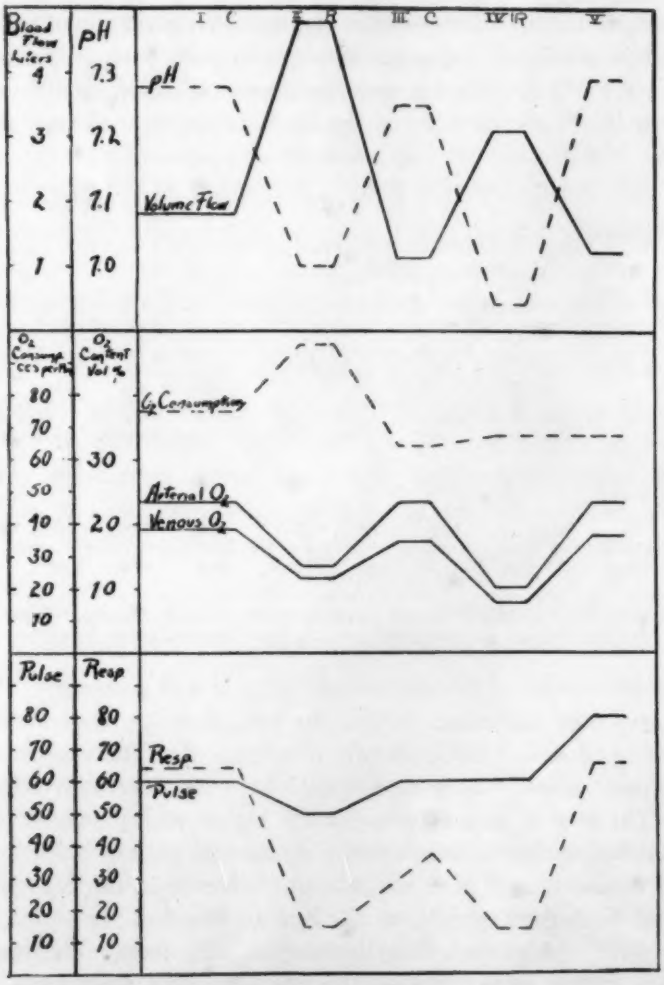

Fig. 3 (Eperiment 11).—Effects of constriction; *C*, constriction; *R*, release. The striking changes that take place after partial constriction of the trachea, as shown in this chart, are: (1) immediate increase in the blood flow with a synchronous decrease in the p_H of the blood; (2) a tendency for the curves for the oxygen content of the arterial and venous blood to approach one another at a lower level than normal, and (3) marked slowing of the respiratory rate.

obstruction but were of greater degree. The alkalinity of the blood was much diminished and the volume flow increased greatly. The results of severe constriction in a typical experiment are shown in Figure 3 and the average figures for four experiments are given in Table 2.

Release of Constriction.—When the constriction was released, the pulse rate usually increased together with the respirations and slowly returned to normal as the respirations became slower. The oxygen consumption increased suddenly on release of constriction but rapidly returned to normal (Fig. 2). The values for the blood gases, blood reaction and volume flow approached those obtained during the first control period. The complete figures for each individual experiment are given in Table 3.

TABLE 2.—*Effects of Severe Tracheal Obstruction (Average Figures for Four Experiments)* *

Average weight of animals, 10.9 kg.

	Pulse Rate	Respiration Rate	Oxygen Consumption per Minute, C.c.	Arterial Oxygen, per Cent. by Volume	Venous Oxygen, per Cent. by Volume	Venous CO_2, per Cent. by Volume	Arterial CO_2, per Cent. by Volume	p_H	Volume Flow, Liters	Output per Beat, C.c.
Before constriction.....	59	37	70.9	22.2	17.3	51.1	46.7	7.27	1.65	28.3
During severe tracheal constriction.....	50	13	79.3	12.2	9.9	67.2	66.5	6.98	3.88	68.2
Following release of constriction..	88	31	67.8	22.3	17.0	51.5	45.8	7.25	1.31	18.4

* In some of the experiments, all the functions listed were not determined. The figures in the table represent averages for the experiments in which determinations were made.

Administration of Alkali.—Because of the fact that a decreased alkalinity of the blood was always associated with an increased volume flow, it was decided to alter the reaction of the blood by injecting alkali in order to study further the effect of the hydrogen ion concentration on the volume flow. Hence, in one animal in which partial tracheal obstruction had been produced, 45 c.c. of normal sodium bicarbonate was injected intravenously. The dyspnea was diminished immediately though the respirations were very shallow. The pulse rate did not change. The oxygen consumption was much lower but the arterial blood was normally saturated. The hydrogen ion concentration and circulatory minute volume returned to the normal level. The figures for this experiment are given in Table 4. The results are pictured in Figure 4, and it is of interest to contrast these with those in Figure 3.

TABLE 3.—*Effects of Partial Tracheal Obstruction on the Circulation and the Respiration* *

	Pulse Rate	Respiration Rate	Oxygen Consumption, per Minute, C.c.	Arterial Oxygen, per Cent. by Volume	Venous Oxygen, per Cent. by Volume	Venous CO_2, per Cent. by Volume	Arterial CO_2, per Cent. by Volume	p_H	Minute Ventilation, Liters	Volume Flow, Liters	Output per Beat, C.c.
Experiment 2 Weight, 9.5 kg.											
Before constriction....	45	..	....	20.4	14.3	52.5	49.5	....	....	....	....
During mild constriction.....	80	..	....	21.7	17.3	48.7	46.9	....	....	....	....
One-half hour following release.....	..	..	....	20.3	15.4	51.9	48.5	....	....	....	....
Experiment 4 Weight, 10 kg.											
Before constriction....	60	18	....	18.9	13.2	46.3	39.1	7.24	....	....	....
During mild constriction.....	96	18	....	19.4	15.7	47.0	45.5	7.14	....	....	....
One and one-half hrs. following release....	90	36	....	19.6	13.5	42.8	35.1	7.25	....	....	....
Experiment 5 Weight, 9.8 kg.											
Before constriction....	58	30	....	18.0	11.8	53.3	48.7	7.28	....	....	....
During severe constriction.....	60	13	....	12.3	9.1	56.4	55.2	7.07	....	....	....
One-half hour following release.....	30	22	....	18.6	13.2	50.6	46.4	7.23	....	....	....
Experiment 6 Weight, 12.9 kg.											
Before constriction....	60	25	72.0	22.3	17.6	44.9	41.2	7.31	....	1.53	25.5
During constriction....	60	17	85.8	22.5	18.8	57.6	54.8	7.11	....	2.32	38.7
Three-fourths hour following release....	60	..	96.5	22.3	17.1	49.5	45.0	7.24	....	1.86	30.9
Experiment 7 Weight, 6 kg.											
Before constriction....	57	22	42.0	21.6	16.9	42.1	36.2	....	4.09	0.80	15.6
During severe constriction.....	72	9	59.1	21.9	17.8	53.0	51.0	....	1.04	1.44	20.0
One-half hour following release.....	66	21	44.5	21.6	15.2	46.1	33.6	....	4.68	0.69	....
Experiment 10 Weight, 9.1 kg.											
Before constriction....	56	15	61.6	24.4	21.1	45.2	39.5	7.25	4.80	1.90	34.0
During severe constriction.....	66	11	75.0	13.0	11.0	68.1	67.7	6:91	1.50	3.75	56.9
One hour following release.....	64	14	60.4	24.2	19.6	51.2	40.8	7.21	....	1.35	21.1
Experiment 11 Weight, 12.5 kg.											
Before constriction....	60	64	75.0	23.3	19.1	52.0	47.8	7.28	6.70	1.80	30.0
During severe constriction.....	50	15	96.0	13.6	11.6	74.1	71.4	7.00	1.13	4.80	96.0
Three-fourths hour following release....	60	37	76.0	23.2	17.2	54.0	50.8	7.25	6.53	1.26	21.0
Experiment 11 †											
Before constriction....	60	37	76.0	23.2	17.2	54.0	50.8	7.25	6.53	1.26	21.0
During severe constriction.....	60	14	67.0	10.1	7.9	70.3	71.5	6.94	1.59	3.10	51.7
One hour following release.....	100	49	67.0	23.2	18.1	50.0	42.2	7.29	6.95	1.31	13.1
Experiment 19 Weight, 7.5 kg.											
Before constriction....	60	21	52.1	19.9	15.3	50.8	46.8	7.25	3.78	1.13	18.9
During mild constriction.....	68	15	55.9	20.7	17.0	54.6	51.7	7.14	2.72	1.51	22.2

* The figures are incomplete in Experiments 2, 4, and 5 as the animals were not breathing through a spirometer.

† After an interval of an hour, all the procedures in this experiment were repeated.

COMMENT

There are several theoretical objections to the method employed in these experiments: First, the use of anesthesia. As Henderson [6] points out, anesthesia may profoundly alter the volume flow. Morphin was used because Marshall [7] has found that morphin has no marked effect on the volume flow of the normal dog. Furthermore, the tables show that the final control blood flow was in nearly all instances of the same order of magnitude as the first control determination. This could not be true if morphin exerted any marked continuous depressant effect on the circulation. In such an instance the blood flow three or four hours after 1 grain (0.06 gm.) of morphin, would be distinctly lower than one hour after the administration of the drug.

TABLE 4.—*Effects of the Injection of Alkali When the Animal Has Partial Tracheal Obstruction*

Experiment 19; weight, 7.5 kg.

	Pulse Rate	Respiration Rate	Oxygen Consumption, per Minute, C.c.	Arterial Oxygen, per Cent. by Volume	Venous Oxygen, per Cent. by Volume	Venous CO_2, per Cent. by Volume	Arterial CO_2, per Cent. by Volume	p_H	Minute Ventilation, Liters	Volume Flow, Liters	Output per Beat, C.c.
Before constriction....	60	21	52.1	19.9	15.3	50.8	46.8	7.25	3.78	1.13	18.9
During mild tracheal constriction.....	68	15	55.9	20.7	17.0	54.6	51.7	7.14	2.72	1.51	22.2
Shortly following injection of 45c.c. normal sodium carbonate.....	68	..	38.5	19.0	15.3	96.9	93.8	7.31	1.82	1.04	15.3

Second, the effect of high oxygen tension. Lavorsier and Seguin [8] and, more recently, Benedict and Higgins [9] showed that the oxygen consumption is not increased by breathing pure oxygen. That the minute volume of blood is not altered is shown by a comparison of the results obtained by this method with those obtained by Marshall when the animals were breathing air. The values are given in Table 5.

However, the objection might be raised that obstruction to the respirations has a different effect when the animals are breathing pure oxygen instead of air. It was shown in parallel experiments that respiratory

6. Henderson, Y.: Volume Changes of the Heart, Physiological Rev. **3**:165 (April) 1923.

7. Marshall, E. K., Jr.: Personal communication to the authors.

8. Lavoisier and Seguin: Second Memoir sur le Respiration les Animeaux, Ann. de Chem. **41**:318, 1814.

9. Benedict, F. G., and Higgins, H. L.: Effects on Man at Rest of Breathing Oxygen-Rich Gas Mixtures, Am. J. Physiol. **28**, 1911.

obstruction affects the blood gases in the same manner, regardless of whether air or oxygen is breathed. In both instances a slight degree of constriction causes moderate carbon dioxid retention but no anoxemia, whereas extreme degrees of obstruction cause great carbon dioxid retention and anoxemia. These figures are given in Table 6.

The important results of respiratory obstruction that were found in these experiments include: (1) acidosis; (2) increased blood flow with

TABLE 5.—*Effect of Morphin and Oxygen on the Blood Flow*

Results Obtained by Dr. E. K. Marshall, Jr., on Unanesthetized Dogs *		Results Obtained by Authors on Dogs Anesthetized with Morphin and Breathing Oxygen			
Dog Number	Volume Flow per Minute per Kilogram, C.c.	Dog Number	Volume Flow per Minute per Kilogram, C.c.	Dog Number	Volume Flow per Minute per Kilogram, C.c.
1	109	6	119	15	147
2	122	7	148	16	200
3	154	10	210	17	155
4	154	11	144	18	170
		12	151	19	151
		14	153		
Average.....	135	.....			150

* Dr. Marshall very kindly furnished the figures for his normal dogs. His values for each animal represent the average of a number of determinations. Our figures represent only one determination on each animal. It can be seen that there is no great difference, the values for the trained animals being only slightly lower than those for the morphinized animals.

TABLE 6.—*Similarity of Blood Gases Following Mild and Severe Constriction When (1) Air Is Breathed and (2) Pure Oxygen Is Used*

Experiment Number	Gas Breathed	Degree of Constriction	Arterial Oxygen, per Cent. by Volume			Venous Oxygen, per Cent. by Volume			Arterial CO_2, per Cent. by Volume			Venous CO_2, per Cent. by Volume		
			Before Constriction	During Constriction	After Constriction	Before Constriction	During Constriction	After Constriction	Before Constriction	During Constriction	After Constriction	Before Constriction	During Constriction	After Constriction
4	Air	Mild	18.9	19.4	19.6	13.2	15.7	13.5	39.1	45.5	35.1	46.3	47.0	35.1
6	Oxygen	Mild	22.3	22.5	22.3	17.6	18.8	17.1	41.2	54.8	45.0	44.9	57.6	49.5
5	Air	Severe	18.0	12.3	18.6	11.8	9.1	13.2	48.7	55.2	46.4	53.3	56.4	50.6
10	Oxygen	Severe	24.4	12.0	24.2	21.1	11.0	19.6	39.5	67.7	40.8	45.2	68.1	51.2

a pulse rate that was almost constant; (3) a tendency for the oxygen content of the arterial and venous blood to equalize at a lower level than normal; (4) an increase of the carbon dioxid content of the arterial and venous blood, and (5) marked slowing of the respiratory rate and the diminished minute ventilation. These points together with the effects of the injection of alkali when obstruction was present are discussed as follows:

1. *Acidosis.*—Obstruction to the respirations invariably caused an acidosis that was dependent on the retention of carbon dioxid. The

usual types of acidosis seen clinically—diabetic and renal—are not due to an excess of carbon dioxid but to an excess of nonvolatile acids. In these conditions the carbon dioxid is blown off as a compensatory mechanism and the amount of the gas in the blood is decreased; whereas in the acidosis of respiratory obstruction the carbon dioxid content is increased. This emphasizes the point that has been so frequently made

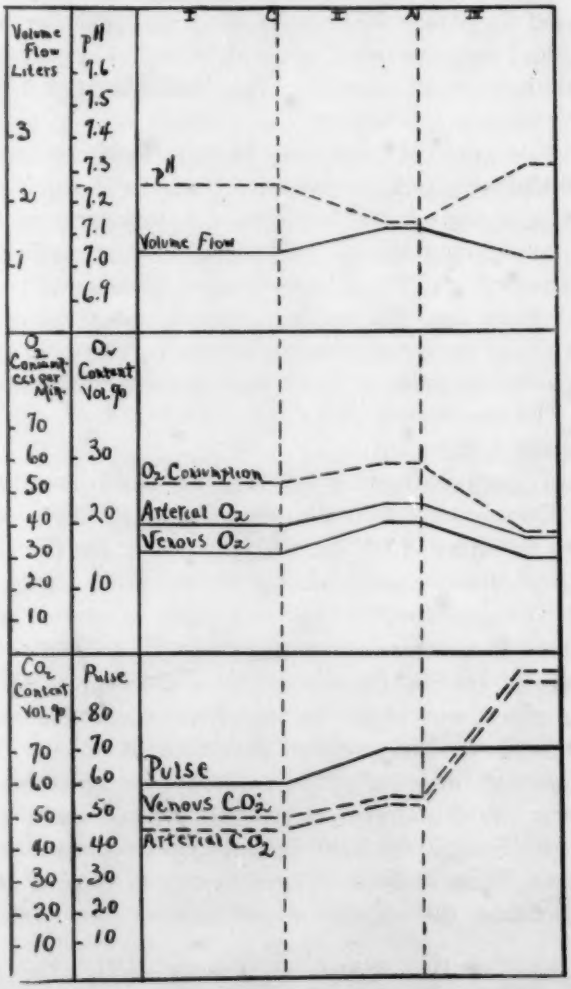

Fig. 4 (Experiment 19).—Effects of injection of alkali when partial tracheal obstruction is present; *C*, constriction; *A*, alkali injection. The changes that take place when alkali is injected intravenously into an animal that has partial tracheal obstruction are: (1) the immediate decrease in the blood flow with a synchronous increase in the p_H of the blood; (2) a decrease in oxygen consumption though the arterial blood remains normally saturated, and (3) a marked increase in the carbon dioxid content of the arterial and venous blood.

by Van Slyke,[10] that the carbon dioxid combining power (or content) of the blood is not an invariable index of the hydrogen ion concentration.

2. *Increased Blood Flow.*—The volume flow frequently increased as much as 100 per cent. when tracheal constriction was produced and in several instances a much greater rise was noted. This is not entirely in accord with the observations of Huggett,[11] who found that an inspiratory resistance caused an increased flow, whereas an expiratory resistance decreased the flow. This discrepancy can probably be explained by the fact that Huggett worked with cats—weaker animals than dogs—and used urethan as an anesthetic. Marshall has shown that urethan alters the circulatory mechanism.

The fact that a normal respiratory mechanism can compensate for an impaired circulation is well recognized. From these experiments one is led to believe that the normal circulation can to a great extent compensate for a failing respiration. When the alveolar tension of carbon dioxid is increased and the alveolar tension of oxygen is diminished, each unit of blood can take up less oxygen and give off less carbon dioxid. Hence, if the total exchange of these gases is to remain unaltered, the number of units of blood passing through the lungs must be increased. The circulation offers the second line of defense against failure of tissue metabolism.

Since respiratory obstruction caused both an acidosis and an increased blood flow, the question naturally arose as to whether the first phenomenon was the cause of the second. This point has been investigated in some detail in another series of experiments which are to be reported elsewhere.[12]

3. *Effect of Respiratory Obstruction on the Absorption of Oxygen and Excretion of Carbon Dioxid.*—With slight degrees of obstruction there was no effect; with moderate degrees of obstruction carbon dioxid retention and acidosis were produced but anoxemia was not found. This was true regardless of whether the animals were breathing oxygen or air (Table 6). With extreme obstruction marked acidosis and anoxemia occurred. Even in the latter instance the oxygen consumption was not decreased. These findings are noteworthy in view of a recent tendency to emphasize the stability of the carbon dioxid mechanism as

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10. Van Slyke, D. D.: Studies of Acidosis, XVII, The Normal and Abnormal Variations in the Acid-Base Balance of the Blood, J. Biol. Chem. **48**:153 (Sept.) 1921.

11. Huggett, A. S.: Studies on the Respiration and Circulation of the Cat, IV, The Heart Output During Respiratory Obstruction, J. Physiol. **59**:373 (Dec.) 1924.

12. Harrison, T. R.; Wilson, C. P., and Blalock, A.: The Effects of Changes in Hydrogen Ion Concentration on the Circulatory Minute Volume in Morphinized Dogs, unpublished.

contrasted with the oxygen mechanism. Thus, Hastings, Neill, Morgan and Binger [13] state:

> In any individual breathing ordinary atmosphere, respiratory hindrance must result in serious anoxemia long before carbon dioxid acidosis has become at all significant.

This conclusion is drawn from work on pneumonia. In this condition the normal lung may, by overventilation, compensate for lack of carbon dioxid excretion in the diseased lung, but cannot compensate for lack of oxygen absorption because the blood through the good lung is already nearly 100 per cent. saturated. With obstruction to the respirations quite a different condition exists. The tension of oxygen in the alveoli may fall by as much as 35 per cent. before anoxemia occurs, but a slight rise in alveolar carbon dioxid tension, uncompensated by overventilation, causes acidosis. Under such conditions the oxygen mechanism is the more stable. That this is also true under normal conditions is evidenced by the work of Burwell and Robinson,[14] who found that the rate of blood flow, determined by the oxygen method, was distinctly less variable than when determined by the carbon dioxid method.

Our findings are in accord with the observations of Hoover,[15] who states:

> Cyanosis does not follow even very severe stenosis of the trachea. It is an impressive fact that a patient may have uncomplicated stenosis of the trachea which will compel the use of the utmost strength for both inspiration and expiration and still show no visible evidence of anoxemia.

4. *Diminished Minute Ventilation.*—Obstruction to the respirations decreases the amount of air that can be breathed in one respiration, and increases the amount of time necessary to inhale or exhale a given amount. Under such conditions rapid, shallow breathing is extremely inefficient because a great part of the expiratory effort is expended in washing the dead space; hence it seems that slow respirations of the greatest possible depth are more efficient than shallow respirations at a more rapid rate.

In the animals with respiratory obstruction, the respirations were actually slow and observation of the animals gave the impression that the greatest possible effort was being expended with each expiration and inspiration.

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13. Hastings, A. B.; Neill, J. M.; Morgan, H. J., and Binger, C. A. L.: Blood Reaction and Blood Gases in Pneumonia, J. Clin. Investigation **1**:125, 1924.

14. Burwell, C. S., and Robinson, G. C.: The Gaseous Content of the Blood and the Output of the Heart in Normal Resting Adults, J. Clin. Investigation **1**:87, 1924.

15. Hoover, C. F.: Nelson's Loose Leaf Living Medicine, Thomas Nelson and Sons, **3**:393.

The question as to why the respiratory mechanism should function in the most efficient manner under these conditions, is of some interest. We believe that this can be partially accounted for by the acidosis, which is usually characterized clinically by hyperpnea rather than polypnea. However, it is possible that the Hering-Brauer reflex enters into this mechanism and, since no experiments were done with the vagi cut or frozen, this point is not definitely settled.

5. *Effect of Alkali When Obstruction Is Present.*—Since acidosis is one of the most striking effects of obstruction, the question naturally arises as to the possibility of beneficial effects from alkaline therapy.

In the one animal to which alkali was given during the period of respiratory obstruction, rather striking effects were obtained. The respirations were greatly diminished and the animal no longer appeared dyspneic; the blood flow returned to the normal level. However—and this seems to be an important fact—the oxygen consumption was decreased. Alkali depressed the respirations so much that the intake of oxygen became subnormal.

These findings indicate that whereas beneficial results may be expected clinically from giving alkali to patients with respiratory obstruction due to inoperable causes, the administration should be carried out very cautiously and slowly. Furthermore, since alkali, being a respiratory depressant, greatly diminishes the minute ventilation, it is desirable to have the air breathed rich in oxygen. Therefore, alkaline therapy should not be attempted unless oxygen is also given.

If suitable cases of respiratory obstruction are encountered in the future, we plan to make a clinical study of the effects of administering alkali. From the present data no very definite conclusions can be drawn. However, it is suggested that such therapy may prove valuable in diphtheria and in cases of moderately severe laryngeal edema such as sometimes follow bronchoscopy. In such cases tracheotomy is undesirable, and we believe that it may be avoided in some instances by the giving of alkali and oxygen. This treatment may prove of palliative value in the severe paroxysms of dyspnea in cases of mediastinal aneurysm or in tumor pressing on the trachea.

SUMMARY AND CONCLUSIONS

Obstruction to the respirations has been produced in dogs, anesthetized with morphin. The pulse rate, respiratory rate, minute ventilation, oxygen consumption, arterial and venous oxygen and carbon dioxid contents, hydrogen ion concentration, and circulatory minute volume have been studied. The following results have been obtained:

1. Partial obstruction of the tracheal cannula caused slow, shallow breathing.

2. An increase of the carbon dioxid content of the arterial and venous blood occurred with moderate degrees of obstruction, whereas anoxemia did not occur until the obstruction became extreme.

3. Even with extreme degrees of obstruction, the oxygen consumption was not decreased.

4. Acidosis, due to the accumulation of carbon dioxid, was a constant finding.

5. The circulatory minute volume was very much increased although the pulse rate was practically unchanged.

6. In one animal to which alkali was given intravenously during the period of tracheal obstruction, the hydrogen ion concentration and blood flow became normal but the minute ventilation and oxygen consumption were decreased below the normal values. The dyspnea appeared to be relieved. From these observations the following conclusions are drawn:

(*a*) A healthy circulation may partially compensate for a failing respiratory mechanism.

(*b*) When the lungs are normal and tracheal obstruction is produced, the carbon dioxid content of the blood is elevated quite markedly before anoxemia occurs.

(*c*) Alkaline therapy may be of value in cases of tracheal obstruction due to inoperable causes and in laryngeal edema following instrumentation. Whenever alkali is administered, oxygen should also be given.

POSTOPERATIVE COLONBACILLURIA*

INCIDENCE IN ONE HUNDRED AND THIRTY CASES FOLLOWING SURGICAL PROCEDURES

CHARLES C. PINKERTON, M.D.
AKRON, OHIO

The appearance of the colon bacillus in the urinary tract in health following gestation, disease or injury, and especially following surgical operation, is a problem of peculiar interest to the profession.

When the colon bacillus was first isolated from human feces by Emmerich in 1885 he thought it to be the specific cause of Asiatic cholera but, later, it was found to be a normal habitant of the feces. However, its presence in appreciable numbers in uncontaminated urine has usually been considered as associated with pathologic change, for the urinary tract is not considered the natural locality of the colon bacillus.

In searching the literature one is impressed with the variant conditions during or following which a colonbacilluria exists, aside from certain saprophytic strains occurring in apparently normal subjects. It is quite commonly intercurrent in the infectious diseases. Colon bacillus pyelitis frequently complicates the diseases of childhood. Such diversified conditions as accidental injury with external lacerations, general run down state due to overwork, and cyluria (caused apparently by *Filaria sanguinis-hominis*) have been accompanied or followed by a colon bacillus infection of the kidneys.

Obstetricians and gynecologists always have been confronted with complications due to urinary tract infection, and since the discovery of the colon bacillus different strains of this organism are found in a rather large majority of cases as the predominating or the only infecting agent. Often the general surgeon is faced with a laboratory report that suggests infection of the urinary system, and in this study we have embodied the incidence and significance of colonbacilluria following surgical operations.

Severe infections of the upper urinary tract such as pyelonephritis or pyelocystitis are not altogether uncommon after operative procedure. Usually bacilli of the colon group are found as the cause. It may be that they overgrow and crowd out a primary invader, such as the

* From the Graduate School of Medicine of the University of Pennsylvania and the Akron City Hospital, in partial fulfilment of requirements for the degree of master of medical science.

staphylococcus or the streptococcus. Stirling [1] thinks that if careful search is made an organism other than the colon bacillus may be isolated in certain cases. In his series of 175 cases of pyelonephritis, 13 per cent. followed surgical operations.

VIRULENCE

Many are of the opinion that patients recover from the subjective symptoms of pyelitis after a few days in bed but continue excreting large numbers of colon bacilli in the urine. Meyer-Betz [2] hints that the body, accustomed to the parasitism of *Bacillus coli* in the intestines from birth, adapts itself to the urinary inhabitant through an acquired general immunity or an acquired capacity of the mucosa of the renal pelvis to prevent passage of *Bacillus coli* into the blood.

Persistent colonbacilluria without symptoms is a phenomenon that is not uncommon. Graff [3] believes that after colon bacilli have reached the renal pelvis, bacteriuria may be present for weeks, months or years without causing symptoms. He emphasizes the constant danger that some special circumstance may be the exciting cause of an acute infection with marked subjective and objective symptoms. Koll [4] in 1915 expressed the view that saprophytic bacteria do not exist in the upper urinary system but are found only in the urethra and the prostate. Hess,[5] in his experimental work, caused rabbits to pass *Bacillus coli* rapidly through the kidneys without producing lesions.

Different opinions are held as to the virulence of *Bacillus coli* in the urinary tract. Many authorities believe that it varies within rather wide limits. Keyes [6] holds that it is only mildly noxious in the upper urinary tract. The existence of the many strains of this organism probably explains in part its varying pathogenic status in the urinary system. The importance of the local and general resistance of the individual to the colon bacillus in the urinary tract should not be overlooked. Barney [7] has observed several cases in which a state of low resistance due to overwork seemed to be an important etiologic factor.

1. Stirling, W. C., Jr.: Observations on 175 Cases of Pyelonephritis, Surg., Gynec. & Obst. **37**:751 (Dec.) 1923.

2. Meyer-Betz, F.: Uber Primare Colipyelitis, Deutsch. Arch. f. klin. Med. **105**:531, 1912.

3. Graff, H.: Die Koliinfektion der Nieren und ihre Behandlung, Ztschr. f. urol. Chir. **3**:6-32, 1914.

4. Koll, I. S.: Bacteria of the Urinary Organs, Not Including the Tubercle Bacillus, Internat. Abstr. Surg. **20**:349 (April) 1915.

5. Hess, Otto: Experimentelle Untersuchungen über die Bacterium Coli Infektion der Hernwege, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **26**:135, 1913.

6. Keyes, E. L.: Diseases of the Genito-Urinary Organs, New York, D. Appleton & Co., 1913, pp. 328-337.

7. Barney, J. D.: Acute Colon Bacillus Infections of the Urinary Tract, J. A. M. A. **71**:1642 (Nov. 16) 1918.

ETIOLOGIC FACTORS IN GENERAL

Thompson-Walker [8] and others point to the intestinal tract with conditions such as protracted constipation or severe diarrhea as the source of the organism in the urine. Rawls [9] reported fourteen cases of urinary tract infection due to the colon bacillus occurring after operation, and accounted for the primary foci in six different localities as follows: infected ectopic gestation and abdominal wound; appendiceal and pelvic abscess; carcinoma of the stomach and gallbladder; appendix alone; pelvic abscess, and perinephritic abscess.

The incidence of colonbacilluria among women is greater than among men and the female sex also predominates in the number seeking treatment because of urinary tract symptoms. Sterling [1] points out that one reason for this condition is doubtless lack of drainage in the female urinary system because the generative organs encroach to a greater or lesser extent on the urinary tract. Baisch [10] found that when women were confined to bed and were allowed to void only twice in twenty-four hours *Bacillus coli* invariably could be cultivated from the external urethra and its vicinity within five days. Cabot [11] found colon bacilli in the urine in about 25 per cent. of a series of cases studied during pregnancy.

The right kidney and ureter are involved more often than the left. Kretschmer [12] cited Franke, who was able by injecting the lymphatics of the large bowel to show that the lymphatics of the right side pass over the right kidney capsule. Franke concluded that there exists on the right side and probably on the left a direct communication between the large bowel and the kidney by way of the lymphatics. Kretschmer maintained that constipation is one of the primary predisposing causes of pyelitis, explaining that the colon bacilli arrive in greater numbers after their increased production in the bowel. He noted the large number of cases of pyelitis found in follicular enteritis and cited Tavel's postoperative goiter case in which the wound became infected with *Bacillus coli,* the patient having had a severe attack of gastro-enteritis. He also cited Asch's four cases of bacillus coli infection of the urinary

8. Thompson-Walker, J. W.: Acute Pyelitis, Pyelonephritis and Suppurative Nephritis, Practitioner **36**:655, 1911.

9. Rawls, R. M.: B. Coli Infections of the Urinary Tract, M. Rec. **81**:359 (Feb. 24) 1912.

10. Baisch, A.: Ztschr. f. Geburtsh. u. Gynäk. **8**:124, 1904.

11. Cabot, H.: The Rôle of the Colon Bacillus in Infections of the Kidney, New York State J. Med. **21**:35 (Feb.) 1921.

12. Kretschmer, H. L.: Pyelitis of Pregnancy, J. A. M. A. **81**:1585 (Nov. 10) 1923.

tract cured by treating the associated constipation. Français,[13] in three cases of renovesical colon bacillus infection due to cecal stasis, went so far as to treat by operation (colostomy and ileocolostomy) the cause of the stasis, reporting a disappearance of the bacilluria and complete alleviation of the urinary symptoms. On the other hand, Hess,[5] in his extensive animal experimentation, produced fecal stasis through opium administration for a period of more than three months with simultaneous constriction of one ureter, and at necropsy found no microscopic lesions in the urinary tract, *Bacillus coli* being present only in the intestinal tract.

The different theories advanced as to the effect, directly or indirectly, of surgical operation on *Bacillus coli* infections of the urinary tract are an interesting phase of this subject. Furniss [14] pointed to wounds infected with intestinal contents as a potential source of urinary tract infection. He laid stress on his belief that renal infections are often caused by the breaking loose from the wound region of infected thrombi that reach the kidney by the hematogenous route, and observed the process as a sudden, acute condition occurring several days after the operation. In his experience operations on the intestinal canal also predispose to urinary tract infection. He believed that many cases occurred in which there never had been any antecedent catheterization, cystitis or other infection of the urinary system.

In a logical discussion of the reasons for postoperative urinary tract infection, Jacobson and Keller [15] point out certain unanatomic conditions remaining after operations in which portions of the urinary tract are distorted. Trauma and congestion with interruption of the blood supply follow all operations in which the urinary bladder is separated from its attachments. In their experience cystoscopic examination following such operations often revealed anatomic malposition of the base, distortion of the trigon, displacement of the ureteral orifices and swelling with edema about the urethral orifice. Often pockets are left in the bladder which are seldom free from residual urine.

Of vital importance in the etiology of urinary infection, possibly of more importance than the presence of the organisms, is that condition of the urinary tract which has been referred to by different authorities as the "prepared soil." Keyes [6] described those factors, which usually follow one another in rapid sequence, as obstruction (due to prostate,

13. Français, H.: J. d'urol. méd. et chir. **16**:425, 1923; abstr., Surg. Gynec. & Obst. **38**:442 (May) 1924.

14. Furniss, H. D.: Postoperative Renal Infection, J.A.M.A. **61**:957 (Sept. 20) 1913.

15. Jacobson, J. H., and Keller, J. G.: Postoperative Retention of Urine and Cystitis, J. A. M. A. **57**:1981 (Dec. 16) 1911.

stricture, stone or tumor) followed by retention, congestion and vascular changes, stretching and atony of the bladder with consequent residual urine, and the addition possibly of trauma. Here the preparation is complete for bacterial invasion. He declares that no other organism except the tubercle bacillus and the gonococcus can take root and multiply in the urinary tract unless the soil on which they flourish is congested, and asserts that bacteria are not the most essential agents in infection of the urinary tract.

Cabot [16] in his well known monograph "The Doctrine of the Prepared Soil" has followed a very similar line of reasoning. He considers postoperative congestion of the whole urinary tract coupled with low resistance to the colon bacillus typical preparation of the soil, which will usually be followed by a flourishing growth of the organisms present. Such congestion he says, is often due to retention, which is followed in turn by distention and often by sudden emptying of the bladder by catheterization of the patient.

In 1911 Brewer [17] published some of the results of his animal experimentation, in which he observed in part the effect of more or less complete anemia, hyperemia and other vascular changes in lowering the resistance of the kidney to blood infection. He found that such changes in the blood supply so lowered the resistance of the organ as to result in definite surgical lesions.

Trauma is regarded as a most important element in the causation of urinary tract infections when organisms such as *Bacillus coli* are present. Koll [18] in 1915, after experimental work on animals, reported that the nontraumatized kidney in the absence of obstruction usually overcomes spontaneously the invasion of virulent micro-organisms. Traumatic injury with the organisms present may not be always a certain exciting factor, however, for certain observers have found the urinary tract capable of protecting itself against invading micro-organisms, especially the colon bacillus, even in the presence of trauma, provided no other factors such as obstruction are coincident. Barber and Draper [19] concluded after a series of experiments on animals that traumatism of the ureter results in a mechanically changed kidney that may be infected later.

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16. Cabot, H.: Doctrine of the Prepared Soil, Canad. M. A. J. **81**:610 (Sept.) 1921.

17. Brewer, G. E.: Observations on Acute Hemic Infections of the Kidney, Am. J. Urol. **19**:549 (Dec.) 1913.

18. Koll, Irwin S.: The Experimental Effect of the Colon Bacillus on the Kidney, J. A. M. A. **64**:297 (Jan. 23) 1915.

19. Barber, W. H., and Draper, J. W.: Renal Infections, J. A. M. A. **64**:205 (Jan. 16) 1915.

Obstruction is conceded by practically all to be directly or indirectly the most important factor in preparing the urinary system for bacterial invasion, and this leads us to a consideration of the part played by residual urine. Curtis [20] has made careful observations on the management of stasis of vesical urine, especially in the female bladder, and has pointed out repeatedly the great increase in the danger of infection of the urinary tract wherever there are postoperative accumulations of residual urine. In 1923 he found in a series of 1,595 convalescent female patients that residual urine of more than an ounce (30 c.c.) was present after a return to spontaneous micturition in more than 64 per cent. of all repeatedly catheterized patients. The residual urine is the chief cause of infection.

Falls [21] noted *Bacillus coli* in six out of ten cases of residual urine specimens collected from pregnant women. Albeck [22] reported after examination of 250 gynecologic cases that 130 presented bacteriuria. Of the group of 120 without residual urine only sixteen showed bacteriuria. the remaining 104 being sterile. In this series no case of urinary obstruction was present but the bladder had been weakened by age, tumors or displacements.

Mills [23] pointed out the effect of gravity in subjects who have residual urine, describing the funnel shape of the bladder with the apex corresponding to the urethra as shown by the roentgenograph with a bismuth suspension. This observer found that the bismuth suspension in the bladder would not wash out with the patient in the reclining position but that in the sitting position complete evacuation could be accomplished. Furthermore, the wide variation in amounts of urine collected by the catheter in certain of the cases at regular intervals, indicate clearly that the catheter could not be relied on completely to empty the bladder. Some chronically distended bladders with lateral pouches would be very difficult to empty completely. In all cases with residual urine, he found bacilluria very common.

Regarding the importance of the catheter as a factor in bladder infections there is some divergence of opinion. Certain clinicians concur in the opinion that some cases of bladder infection are held to be due to catheterization in which this procedure is not the cause. Curtis [20]

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20. Curtis, A. H.: Management of the Female Urinary Bladder After Operation and During Pregnancy, J. A. M. A. **80**:1126 (April 2) 1923.

21. Falls, F. H.: A Contribution to the Study of Pyelitis in Pregnancy, J. A. M. A. **81**:1590 (Nov. 10) 1923.

22. Albeck, F.: Untersuchungen uber die Funktion der Weiblechen Harnblase bei Frauen Krankheiten, Monatschr. f. Geburtsh. u. Gynäk. **38**:585, 1913.

23. Mills, R. G.: Incidence of Postoperative Catheterization, Ann. Surg. **79**:813 (June) 1924.

advocates the removal of retained urine and avoidance of pain due to back pressure, with its danger of renal infection. He considers it unwise to cease abruptly the use of the catheter when there is residual urine. Cabot [16] contends that the catheter must be used whenever necessary to prevent distention, for the sudden emptying of a distended bladder causes vascular changes that permit infection of the bladder mucosa. Jacobson and Keller [15] likewise contend that the catheter of itself is not always the cause of cystitis but that bacterial infection plus retention, trauma and congestion are all more or less necessary factors. Gibbon,[24] on the other hand, and many others insist that catheterization should not be instituted after operation unless necessary for pain due to vesical distention and that other expedients should always be tried primarily in an attempt to have the patient void spontaneously. This seems to be the opinion of the majority of clinical surgeons.

ROUTES OF INVASION

The literature is replete with accounts of experimental work done by many investigators in attempts to determine the route by which the colon bacillus reaches the renal and ureteral tissues. The late trend of opinion in this question leans strongly toward the hematogenous route as being by far the most common one.

When there is a marked degree of obstruction with its resulting vascular changes due to malposition of the kidney, calculus, neoplasm or enlarged prostate, an ascending infection along the ureter may occur, possibly in association with a hematogenous or lymphogenous transfer of the infecting organisms. The possibility of bacteria reaching the kidneys by direct extension or continuity must also be borne in mind. Clark [25] observed that the bladder in women is rendered especially vulnerable to an adjacent pathologic condition by the intimate anatomic relation of the surrounding genitalia. Furniss [14] cites Bauersein, who found cystitis at eighteen necropsies following operations for carcinoma but no evidence of the infection extending through the bladder wall. Bauersein considered the urethra or the hematogenously infected kidney as the source of infection and held that the operative wound was the portal of entry in more of these cases than is generally believed. Cabot and Crabtree [26] assert that colon bacillus infections are usually hematoge-

24. Gibbon, J. H.: Ochsner's Surgical Diagnosis and Treatment, Philadelphia, Lea & Febiger, **1**:139, 1920.

25. Clark, J. G.: The Relationship Between the Urinary System and Disease of the Female Pelvic Organs, Surg., Gynec. & Obst. **18**:10 (Jan.) 1914.

26. Cabot, H., and Crabtree, E. G.: A Classification of Renal Infections with Particular Reference to Treatment, Boston M. & S. J. **174**:780 (June) 1916.

nous in origin and maintain that *Bacilli coli* circulate in the blood under many conditions, being excreted by the kidneys without producing gross lesions. Crabtree [27] obtained colon bacillus from the blood in 40 per cent. of thirty-two cases of acute pyelitis. Hess [5] concluded that infection may ascend by the lumen of the ureter and its lymphatics. He injected virulent cultures of *Bacillus coli* into the bladder of rabbits, with and without previous irritation, and into the pelvis of the kidney, with and without obstruction of the ureter. This same investigator, however, seems to believe the hematogenous route to be the most common one for he injected *Bacillus coli* into the ear vein of animals and was able to follow the bacterial masses from capsule spaces of glomeruli into efferent tubules within a short time (twenty hours) even when there was no evidence of microscopic changes or hemorrhage. Within a few days thereafter no bacteria could be seen in kidney sections, possibly because they were rapidly eliminated. The changes in both kidneys were identical and the renal lesions almost the same as in ascending infection. As regards the transfer of *Bacillus coli* from the colon to the right kidney via the lymphatics, he contends that the lymph glands normally prevent distribution of micro-organisms.

Barber and Draper [19] found that, given an infected bladder and making due allowance for local and systemic resistance, the ureterovesical valves may be cut without resulting infection, and showed that the degree of protection afforded by these structures was probably overestimated. At the same time, they found that the kidneys were protected from urogenous infection and hydropic degeneration by the peristaltic action of the ureter.

INCIDENCE AND SIGNIFICANCE OF COLONBACILLURIA AFTER OPERATION

In 1909 Rogers [28] of Calcutta recorded a series of eight gynecologic patients who had been operated on and in whom an acute febrile condition had developed as a postoperative complication. The colon bacillus was isolated from the urine in every case and he attributed the disturbed convalescence to urinary tract infection.

In 1911 Williams and Wallace [29] of Liverpool, noting Roger's experience, decided they would undertake to determine the incidence of

27. Cabot, H., and Crabtree, E. G.: Etiology and Pathology of Nontuberculous Renal Infections, Surg., Gynec. & Obst. **33**:495 (Nov.) 1916.

28. Rogers, L.: Genito-Urinary B. Coli Infections as a Frequent Cause of Fever, Therapist **20**:1-4, 1915.

29. Williams, R. L., and Wallace, A. J.: The Incidence, Characters and Significance of B. Coli in the Urine of Gynecological Patients Before and After Operation, Liverpool M. Chir. J. **31**:95, 1911.

Bacillus coli in the urine of gynecologic patients and any correlation between postoperative rises of temperature and the presence of this organism in the urine. Colon bacillus was found in 44.5 per cent. of cases before operation and in 93 per cent. after operation, with an appreciable increase in the number of colonies in all postoperative cases. The urine from two cases was sterile throughout and one case with sterile urine showed the highest temperature rise of any in the series. Four other cases were tested after operation only, and a growth obtained in each. There was no marked temperature rise in any case with colonbacilluria. Their conclusions were, in part, that the presence of *Bacillus coli* in the urine of these patients was of little importance and they suggested the use of agglutination tests when there is evidence in the urine of inflammatory changes coincident with colonbacilluria.

Rawls,[30] in his study of bacilluria in forty gynecologic cases, found *Bacillus coli* in 20 per cent. before, and 27.5 per cent. after, operation, with more extensive growths after operation. Only one patient in his series had symptoms of urinary infection. The other cases did not present objective or subjective evidence of the absence or presence of bacilluria. He observed that the colon bacillus, as found in gynecologic and obstetric patients, was most often a saprophyte becoming pathogenic when conditions were ripe, such as those which follow obstruction and unanatomic relations.

What then, are the most essential elements in a diagnosis of infection of the urinary tract due to the colon bacillus? Cabot and Crabtree [27] consider the following factors necessary: (*a*) suggestive clinical evidence; (*b*) bacilli in large numbers in the urine; (*c*) a trace of albumin, also red blood corpuscles and leukocytes in the urine, and (*d*) renal function below normal.

METHODS AND RESULTS IN EXPERIMENTAL WORK

During the last year I have made a study of colonbacilluria [31] in the surgical service of Dr. Carl R. Steinke at the City Hospital of Akron.

30. Rawls, R. M.: B. Coli Infections as a Complication in Gynecology and Obstetrics, Tr. Am. Gynec. Soc. **40**:475, 1915.

31. I wish to mention the uniformly satisfactory results which may be obtained by the use of the so-called Greiss test, as a time saving measure for the detection of bacterial activity in urine which has recently been secreted by the kidneys. In 18 out of 20 cases in which the modified Greiss test indicated bacterial activity in the kidneys, the results were confirmed by cultures. This procedure should be of some value, I believe, to the laboratorian and clinician when renal specimens have been collected for culture by catheterization of the ureters. Weltmann, Oskar: Wien. klin. Wchnschr. **35**:688 (Aug. 10) 1922.

Urine was collected,[32] using care to avoid contamination, and forwarded to the laboratory in sterile test tubes a few hours before operation and from four to six days after operation. The catheter was used to collect all specimens except in a certain number of the male patients. These were allowed to void and the specimen collected after about half the vesical urine had passed through the urethra. The object was to carry on the work under varying conditions in order that the results might be based on ordinary careful hospital routine.

The cases observed were not selected. The 130 patients in this series underwent operations that are representative of those commonly performed in the field of general surgery. The ages ranged from 13 to 71 years, the average being 33 years. The youngest patient in whom a postoperative colonbacilluria was found was 13 years, the oldest 60.

There were ninety-four females and thirty-six males in this group. Among the female patients twenty-four, or 25.5 per cent., had colon bacilli in the urine before, and thirty-eight, or 40.4 per cent., after operation. Of the twenty-four who had preoperative colonbacilluria, all but two had postoperative colonbacilluria. Fifty-six, or slightly over half the female patients, were gynecologic. Fifteen, or 26.8 per cent., had

32. Method for Bacterial Diagnosis of Colon Bacilluria:

1. Special precautions must be taken in collection in order to avoid the possibility of contamination with colon bacillus about the genitalia.
2. The urine should be collected in a carefully sterilized receptacle and cultured within a few hours afterward.
3. From 10 to 20 c.c. or more of urine should be transferred with a sterile pipet to a flask containing 100 c.c. or more of plain neutral broth. This culture should be incubated at body temperature. If the contents remain perfectly clear for at least four days it may be safely regarded as a sterile culture. Slight cloudiness is sometimes due to precipitation of urine salts. Smears are negative but 1 c.c. of the culture should be transferred to a slant of agar and incubated forty-eight hours. If no growth appears the culture is sterile. If colon bacilli are present the mediums are likely to become cloudy within forty-eight hours and should be examined as follows: (*a*) A stained smear shows short gram-negative bacilli. If other organisms are present it will be necessary to plate out the culture to isolate the bacilli. For this purpose plain agar plates may be used but plates of Endo medium are to be preferred because on these colon bacilli produce a bright red colony. A short gram-negative bacillus is suggestive of the colon bacilli, but before it can be definitely regarded as such it must (1) be motile (usually sluggish); (2) coagulate milk; (3) produce acid and gas when placed in a fermentation tube containing litmus—glucose bouillon; (4) produces acid and gas when inoculated on a slant of Russell's double sugar agar, and (5) produces indol (some strains produce only small amounts).

preoperative colonbacilluria and twenty-three, or slightly over 41 per cent., showed the organism present in the urine after operation. Of the remaining thirty-eight patients operated on who were not in the gynecologic class, nine, or 23.7 per cent., were positive for colonbacilluria before operation and fifteen, or 39.5 per cent., after operation. It is interesting to note a slight preponderance of those with colonbacilluria among the gynecologic patients.

Among the thirty-six males who were operated on for different conditions there were only two, or 5.5 per cent., showing colon bacilli in the urine before operation. The catheter was used to obtain one specimen, and one patient was allowed to void into a sterile receptacle as described

TABLE 1.—*Incidence of Postoperative Colonbacilluria by Decades*

Age by Decades	Total of 130 in Series	Total of 42 Showing Postoperative Colonbacilluria	Percentage Showing Postoperative Colonbacilluria
From 10 to 19	14	3	21.4
From 20 to 29	53	19	35.8
From 30 to 39	32	12	37.5
From 40 to 49	19	5	26.3
From 50 to 59	9	3	33.3
From 60 to 71	2	0	0

TABLE 2.—*Incidence of Colonbacilluria Before and After Operation Among Male and Female Patients* *

	Number Studied	Number Positive Before Operation	Percentage Positive Before Operation	Number Positive After Operation	Percentage Positive After Operation
Female patients, all types	94	24	25.5	38	40.4
Gynecologic patients only	56	15	26.8	23	41.0
Female patients other than gynecologic	38	9	23.7	15	39.5
Male patients	36	2	5.5	5	13.9

* The female cases are subdivided, showing the incidence among gynecologic and among general surgical cases.

above. Five, or 13.9 per cent., including the two just mentioned, had a postoperative colonbacilluria. Two of the postoperative specimens were obtained by catheterization, and three by voiding.

Female patients presented colonbacilluria before operation about five times more often than males, and after operation about three times more often. The five male patients with colonbacilluria underwent operations for the following conditions: abscess of the jaw; neoplasm of the intestine; acute appendicitis; hemorrhoids (removed by cautery) with appendicitis, and abscess of the neck. *Bacillus coli* was not found in the abscesses.

It seems logical that manipulation of the lower urinary tract, often with slight changes in the shape and position of the urinary bladder

following operation, might contribute to the presence of bacilli in the urine of the gynecologic cases, due mainly to the resultant residual urine. We were not able to determine that such was the case. Constipation also was a frequent complaint among the gynecologic patients but had no bearing on the finding of colon bacilli in the urine of these patients, as the same complaint was noted in the histories of patients with negative urine practically as often as in the ones showing colonbacilluria.

Social status was of no particular importance in the findings. One hundred and five of the series were married and twenty-five were single. In seventeen of the twenty-five unmarried patients the results were negative and in the other eight colon bacilli were found either before or after operation.

Twenty-eight, or 21.5 per cent., of the 130 patients required catheterization after operation because of inability to void. Of the twenty-eight requiring catheterization, three were males who presented no symptoms of bacilluria; the rest were females. Fifteen, or more than one-half, had colon bacilli in the urine at the time, accompanied by burning and frequency significant of a urinary tract infection, although eight of the patients, in whom a colonbacilluria was found, gave a definite history of former urinary tract disturbance. On the other hand, five cases also giving a past history of urinary tract infection presented sterile urine at the time this test was made. There were no cases with objective or subjective findings warranting a diagnosis of pyelitis in the 130 cases studied. Postoperative fever was no more frequent among the positive cases than among the negative.

In only seven of the twenty-six cases positive before operation was the past history free from factors that might contribute to a bacilluria, such as a former major operation, gestation, severe illness or injury. However, it must be borne in mind that any of these patients with such a negative past history might have had an unrecognized pyelitis or other urinary tract infection in childhood, which was unrecognized at the time, or which was not brought out in the history.

In six, or almost 14 per cent., of the cases positive after operation there was a frank colon bacillus infection elsewhere, as shown by culture, which may have been the primary focus of infection with the organisms appearing in the urine via the hematogenous route. One of these patients had a severe infection in the incision, one a pelvic abscess, one an abscess of the jaw, and three had appendiceal abscesses.

We are convinced that, generally speaking, there was a moderate increase in the size and number of the colonies when the colon bacillus appeared after operation over those growths which occurred before operation. The scope and clinical nature of this work precluded any

attempt at this time to isolate and study the many other different organisms that may be found in the urine when cultures are not absolutely sterile.

SUMMARY AND CONCLUSIONS

An attempt was made to determine the importance of laboratory reports that show *Bacillus coli* in the urine of patients following operation.

An unselected series of 130 general surgical cases was studied to determine by culture the incidence and significance of postoperative colonbacilluria.

1. The colon bacillus appears in the urine of a certain percentage of male and female patients who present themselves for surgical operation. The same organism appears in an appreciably larger percentage after operation, often without subjective or objective symptoms of a urinary tract infection.

2. Among female surgical patients of this series colonbacilluria was present from three to five times more often than among male surgical patients.

3. Colon bacilli occurring in the urine in abundance after operation is a presumptive sign of urinary tract infection, but in the absence of other confirmatory evidence does not always account for postoperative complications.

4. Gynecologic cases, as a class, have colon bacilli present in the urine after operation probably more often than any other class of surgical subjects.

159 South Main Street.

SPONTANEOUS DISLOCATION OF THE TENDON OF THE LONG HEAD OF THE BICEPS BRACHII

REPORT OF FOUR CASES *

A. W. MEYER, M.D.
PALO ALTO, CALIF.

I have used the word spontaneous advisedly in order to convey the idea that external trauma, accident or disease is not necessarily involved in the cases I have observed. These dislocations were uncomplicated in the customary sense but not acutally so, because they were all associated with destruction of portions of the articular capsule by use. This, to be sure, is a traumatic destruction but not in the usual sense, for the trauma concerned was not due to external causes but resulted from use of the extremity.

Dislocation of the tendon of the long head of the biceps brachii, uncomplicated by the dislocation of the joint or by external trauma, remains an almost unrecorded and also a disputed thing. After a review of the literature, White [1] in 1884 came to the conclusion that the case observed by him probably was the only genuine one up to that time.

Since 1884 the Index Medicus lists only a single article on this topic, by Robinson [2] in 1902. Robinson diagnosed and demonstrated his case as one of "dislocation of the tendon of the long head of the biceps flexor cubiti," but later reported that "the case shown under the above title did not prove so on operation. The biceps tendon seemed securely held in its groove, but there was a very thickened bursa over the great tuberosity, in relation with the insertion of the supraspinatus. The tuberosity itself was irregular and thickened evidently owing to osteoarthritis." The existence of a greatly thickened supratubercular or subdeltoid bursa in this case is of especial interest to me, because in the many hundreds of cases of use-destruction I never have encountered such a case.

Only a few works on anatomy and surgery mention dislocation of the tendon of the long head of the biceps among surgical lesions. Treves [3] (undated), for example, merely stated that "in certain violent wrenches of the limb the tendon may slip from its groove and be dis-

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* From the department of anatomy, Stanford University School of Medicine.

1. White, J. W.: A Case of Supposed Dislocation of the Tendon of the Long Head of the Biceps Muscle, Am. J. M. Sc. **87**, 1884.

2. Robinson, H. B.: Dislocation of the Long Tendon of the Biceps Flexor Cubiti, Tr. Clin. Soc. London **36**, 1902-1903.

3. Treves, Frederick: Surgical Applied Anatomy, Philadelphia (about 1883).

placed to one or the other side, usually the inner side." The idea that sudden exertion can dislocate the normal tendon is common but probably erroneous.

Davis [4] in 1907, writing in Piersol's Anatomy, declared that "inward dislocation of the tendon of the long head of the biceps muscle has probably occurred from direct violence as an uncomplicated lesion in a few cases." Since a dislocation of the tendon from "direct violence" would undoubtedly have to be complicated by other injuries to skin and muscles, I presume that what Davis really meant was that the dislocation of the tendon may be uncomplicated by dislocation at the shoulder.

In his Applied Anatomy, Davis [5] in 1910 wrote: "This tendon is comparatively rarely luxated, because it is firmly held in place by the transverse humeral ligament. . . . Luxation of the tendon outwardly would be opposed by the insertion of the pectoralis major; therefore it is only displaced inwardly." It seems to follow from this that Davis merely had dislocation of the distal portion of the tendon in mind, for luxation of the proximal portion could not be prevented by the tendon of the pectoralis major.

Under the head "Dislocation of Muscles and Tendons," Da Costa [6] in 1915 stated that "the tendon of the biceps is oftenest displaced," without specifying, however, which biceps tendon is so affected. Da Costa added that the tendon of the flexor carpi ulnaris, peroneus brevis, peroneus longus, tibialis posticus, sartorius and even that of the plantaris may be dislocated. He stated, however, that fracture or chronic arthritis are usually responsible for these dislocations and added that "displacements may exist after a solitary injury. . . . Dislocation of the long head of the biceps may occur laterally early in the progress of rheumatoid arthritis of the shoulder joint, and the displaced tendon may be absorbed."

No one will dispute the fact that external violence may dislocate any organ in the human body, but aside from this it is difficult to see how the tendon of the plantaris or some others mentioned by Da Costa could be dislocated by chronic arthritis. I have seen many effects of severe chronic arthritis in the dissecting room, including marked destruction in the shoulder and other joints, but I have never seen a case of lateral dislocation of the tendon of the long head of the biceps, and on anatomic grounds I doubt whether lateral displacement ever occurs except from external forces that first destroy the tendon of the supraspinatus and joint capsule.

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4. Davis, G. G.: Human Anatomy, Philadelphia, Piersol, 1907.
5. Davis, G. G.: Applied Anatomy, Philadelphia, 1910.
6. Da Costa, J. C.: Modern Surgery, General and Operative, Ed. 2, Philadelphia, 1919.

Binnie [7] in 1907, writing on the surgery of muscles, tendons and bursae, stated that "luxation of the tendon of the biceps has been described. It is difficult to imagine this injury occurring without dislocation or fracture of the head of the humerus." This conclusion of Binnie confirms the opinions of Volkmann and Chassaignac as quoted by White. In Binnie's "Treatise of Regional Surgery" in 1917, Frick [8] spoke only of displacement of the tendons of the peroneus longus and the "tibialis anticus and posticus."

Under the paragraphic caption "slipping of the long head of the biceps" Estes [9] in 1922 stated that "a loose position of this tendinous part of the biceps occasionally causes disability and can be remedied by severing the attachment near the head of the humerus and thus throwing it out of action." As an anatomist largely unfamiliar with surgical procedure I cannot help but express my surprise at the naive and heroic treatment suggested for the alleged condition.

Steindler [10] in 1923 stated:

> The biceps tendon often is displaced from its bed in the sulcus intertubercularis and in the majority of cases only a few strands are left of the intra-articular portion of the tendon, since the rupture occurs very near to the place of origin at the upper margin of the glenoid cavity. Often the upper extra-articular portion of the tendon is adherent to the sulcus intertubercularis, being caught at times under a bony ridge.

I am not at all certain as to the meaning of this paragraph but it would seem that the author had in mind only conditions following rupture of the tendon.

I surmise that the statements of Davis and Da Costa are based largely on the article of White. After a comprehensive review of the literature, White concluded that the cases previously reported "fail altogether to carry conviction, the one case which possesses any strong element of probability being itself open to reasonable doubt." The case referred to by White is that of Soden. In this case the tendon of the long head of the biceps brachii was supposed to have been dislocated by a fall on the elbow which forced the humerus upward against the acromion. Unexpected and strange results, no doubt, often follow accidents, yet it seems unlikely that this tendon could be thus dislocated without other injury to the joint. It would be forced more firmly into

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7. Binnie, J. F.: Surgery of the Muscles, Tendons and Bursae, in Keen, W. W.: Surgery, Its Principles and Practice, Philadelphia, 1907, **2.**

8. Frick, W. J.: Traumata of the Lower Extremity: A Treatise on Regional Surgery **3,** Philadelphia, 1917.

9. Estes, W. L.: Deformities of the Shoulder, in Ochsner, A. J.: Surgical Diagnosis and Treatment **4,** Philadelphia, 1922.

10. Steindler, Arthur: Reconstruction Surgery of the Upper Extremity, in Surgical Monographs, New York, Lewis, Pool and Elting, 1923.

the sulcus by an upward displacement of the humerus, if such were possible without fracture of the acromion. It is much more likely that Soden's case was one in which the tendon had been dislocated before the occurrence of the foregoing accident, that is, that it was similar to those here reported and that the accident only revealed the condition.

After a review of the literature and a four page anatomic description of the shoulder in which White used two figures from Gray not true to life and inadvertently not credited, he gave a fourteen page discussion of a case that he had seen as a consultant *three years previously*. Although White's title is "a case of supposed dislocation of the tendon of the long head of the biceps," he nevertheless concluded his discussion with the opinion that it was one of uncomplicated luxation. Unfortunately, however, neither the case nor White's analysis of it compels this conclusion for White erroneously assumed that: (1) Considerable space normally exists between the acromion and the humerus; (2) the tendon of the long head of the biceps depresses the head of the humerus, thus normally maintaining an acromiohumeral interval; (3) the subscapularis necessarily acts more powerfully as a medial rotator after the humerus has been forced against the acromion; (4) pressure from the displaced tendon of the long head of the biceps on the tendon of the subscapularis stimulates the latter muscle to spasmodic contraction; (5) the dislocated tendon of the long head would itself strongly aid medial rotation of the humerus; (6) the supraspinatus is a powerful lateral rotator; (7) the acromion on the affected side was tilted upward by "the presence of the head (of the humerus, A. W. M.) just beneath its tip," and (8) medial dislocation of the tendon of the biceps will put the tendon on the stretch because the distance between the opposite terminal attachments of the muscle is increased under these circumstances.

It seems unnecessary to discuss these misconceptions for their erroneous nature is self-evident. White also believed that he palpated an empty intertubercular sulcus from 1½ to 2 inches (3.7 to 5 cm.) distal to the acromion where the sulcus is shallow and where it lies beneath the deltoid and the broad tendon of the pectoralis major. He also thought that he felt the dislocated tendon itself, but apparently was somewhat in doubt although he mentioned the fact three times. It is to be doubted whether White could feel the sulcus in the location stated, for he reported that the "bursae and capsule" over the region of this groove "were drawn so tightly and were so tense by reason of their connection with the sheath of the tendon that swelling could not occur (the succeeding symptom . . . will explain my reason for thinking that this sheath was put greatly on the stretch, but not lacerated)." It must also be remembered that the patient was a carpenter and that the

deltoid hence probably was well developed, thus adding to the difficulty of palpating sulcus or tendon. However, the most convincing thing against the genuineness of White's case is its assumed genesis. White stated that the dislocation was produced by a fall from a height of 6 or 8 feet in which the right shoulder was struck a glancing blow from above and medially, *but without subsequent ecchymosis except along the region of the intertubercular sulcus.* It is exceedingly doubtful, indeed, that a blunt edge such as that of a piazza floor could gouge the normal tendon of the biceps out of its groove, detach the articular capsule and not seriously injure the deltoid and the overlying skin. When it is recalled how completely the distal portion of this tendon is covered by the retinaculum and how firmly the articular capsule holds it in the groove in the intertubercular region, dislocation of it under such conditions seems wholly inconceivable, in a normal joint. However, as in the case of Soden, it is possible that the tendon of the biceps in this case had been dislocated before the accident or that it was a case in which the tendon had previously been destroyed and had obtained a secondary attachment in the region of the lesser tuberosity. Since this patient also was a carpenter this assumption gains greatly in probability.

As the tendon of the long head, in all cases of its dislocation which have come to my notice, was still in the sulcus in the region in which White thought that he felt it absent, it seems not unlikely that what White took for the displaced tendon of the long head was the tendon of the short head, which is easily palpable.

I realize fully that an anatomist cannot speak with authority on matters of palpation except that he ought to know fairly well whether a structure is located in a region in which it is alleged to be palpable. I cannot refrain from expressing my skepticism regarding the general statement of Da Costa that a dislocated tendon "can be felt and a hollow exists where it normally lies." Think of palpating the tendon of the plantaris. Da Costa further stated that "when the muscle contracts the tendon is felt to slip from its groove." If so, then it surely cannot have been permanently dislocated nor its groove been palpable. Da Costa further held that "when the biceps is dislocated the head of the bone passes forward (so called subluxation of the humerus)." It must be evident that anterior dislocation of the tendon of the long head of the biceps might tend to displace the humeral head posteriorly but not anteriorily. As a matter of fact, however, the humeral head showed no displacement whatever in the four cases of maximal dislocation of the tendon of the long head which I have observed in the dissecting room, and there is no reason to suppose that postmortem restitution took place.

I saw the first of my four cases some years ago. Since then I have observed three more instances of complete dislocation, making a total of four among 286 cadavers, or 1.25 per cent. Of these, 235 were male and fifty-one female cadavers. Only one of the four cases was observed in the body of a woman. All occurred in adults and the ages ranged between 50 and 80 years.

This is an amazingly high incidence for so strange a happening, but I surmise that an earlier recognition of the occurrence of this condition on my part and a closer scrutiny of the dissecting room material, would have revealed additional cases of incipient dislocation at least. It must be remembered, however, that the incidence of this condition in the general population of the same ages undoubtedly is far lower, for a much smaller percentage of them are hewers of wood and drawers of water. Yet the condition undoubtedly is common enough but remains undiagnosed. I myself failed to recognize two other cases discussed in 1924 as cases of relatively early dislocation.[11] Reference to Figure 7 in that article will show that the "widening" of the intertubercular sulcus on which I commented really represents a transition stage in the dislocation of the tendons.

It is doubtful whether severe or sudden strain, even if prolonged or repeated, can produce this dislocation. It probably cannot be regarded as an effect of sudden exertion for in all these four cases, months and probably decades, if not years, of prolonged wear and strain undoubtedly were necessary for its production. Probably strenuous and long continued use resulting in capsular defects alone can produce the conditions necessary for its occurrence. I have previously reported that considerable destruction of the superior portion of the articular capsule can exist without evident injury or destruction of the tendon of the long head, and the opposite also is true.[11] This fact can be explained only by assuming that the destructive agent is noninflammatory and that the destruction proceeds gradually, for it is only in this way that the parietal layer of the synovial membrane can be destroyed and an unaffected tendon exposed for a considerable extent.

It was not surprising to me that this tendon might be displaced slightly anteriorily while being severed by attrition and before it secured a firm secondary attachment near the lesser tuberosity. But this is quite a different thing from the dislocation of a perfectly intact tendon over an intact lesser tuberosity.

Every anatomist is aware of the varying prominence of the tuberosities and the tubercular crests and hence also of the varying depth of the intertubercular sulcus. But in spite of such variations the tendon

11. Meyer, A. W.: Further Evidences of Attrition in the Human Body, Am. J. Anat. **34**:241 (Sept.) 1924.

of the long head usually is anchored so securely by the strong capsular attachments that bridge the proximal portion of the sulcus, and by the retinaculum bridging it farther distally, that dislocation of the underlying tendon would seem to be impossible as long as these structures are intact. Sudden contraction of the muscle could not injure them sufficiently to disengage the tendon.

The intertubercular sulcus sometimes even extends over the periphery of the articular cartilage and the tendon is held firmly down in the sulcus by muscular tone and contraction. Moreover, during contraction of the biceps, in the position of medial rotation of the arm, the tendon would be pressed against the anterior surface of the greater tuberosity, not forward against the lesser. As long as the tendon of the long head remained in the sulcus it would hence pass obliquely upward and backward from the proximal portion of the sulcus to its point of origin, in the position of medial rotation of the humerus. Consequently, energetic contraction of it in this position would tend to dislocate it backward, not forward. This, however, would be impossible without detachment of the capsule and the insertion of the supraspinatus.

It is true that the more distal portion of the retinaculum—the transverse humeral ligament—varies considerably in strength, but displacement of the tendon in the more distal portion of the sulcus was slight in these four cases. It practically remained in place here. Sometimes the retinaculum immediately distal to the tuberosities forms a thick tendinous band, which would be unlikely to yield under any conceivable intravitam circumstances except external trauma. At other times, however, it is extremely thin and cannot, by itself, be regarded as an important factor in retaining the tendon within the sulcus. But this can be a matter of secondary importance only, for the yielding that must initiate dislocation of this tendon must occur in the intertubercular region at the place of attachment of the articular capsule, which is thickened in this region.

The uninjured tuberosities always form an impassable barrier for the tendon as long as the capsule does not yield. The tendon can only be displaced after being lifted sufficiently to slip over either tuberosity. In the cases I have observed it always was displaced over the lesser tuberosity, never over the greater. The extent to which the tuberosities prevent displacement is, however, determined largely by the position of the brachium. In the position of marked medial rotation the lesser tuberosity ceases to be an obstacle to anterior displacement of the tendon, but unless the latter is relaxed considerably it would be urged against the medial surface of the greater tuberosity under these circumstances, by muscle tone and contraction.

In one of these four cases of dislocation saccular extensions of the articular cavity were contained in the greatly thickened capsule in the

region of the sulcus. These diverticula were about 2 by 0.5 cm. in size and opened by means of narrow necks into the proximal portion of the intertubercular sulcus. Both diverticula had a trabeculated wall and probably were produced by contact of the articular capsule with the coracoid, between which and the tuberosities it had been rolled in every medial rotation of the brachium. That these capsular diverticula probably were formed in this way is suggested by such facts as those reported by me in 1921 and 1924.[12]

In the latter article I stated that two superimposed bursae sometimes are found in the region of the olecranon. I recently have observed a similar condition under the acromion. In addition to the normal subdeltoid or subacromial bursae, an additional small bursa was contained in the connective tissue overlying the periosteum on the under surface of the acromion. This bursa, which was approximately a centimeter in diameter, very evidently had formed in the subacromial connective tissue by contact with the greater tuberosity during abduction. However, the implication is not that there necessarily exists a similar direct contact between the humerus and the coracoid in such cases as those just referred to. That is ordinarily impossible.

The only case in which I have observed polishing of the coracoid was one of cancer *en cuirasse,* referred to in a former paper.[13] In this case neoplastic infiltration and consequent contraction of the greater pectoral muscles had drawn the humeri forward against the coracoids and resulted in partial destruction of them and of polishing of their surfaces and of the contiguous part of the heads of the humeri. Before this contact was possible the anterior portion of the articular capsule had to be destroyed, to be sure. The same thing applies to the periosteum over the coracoid, the articular cartilage of the humeral head and to the intervening connective tissue. Aside from this case, I have never seen it, and I know of no evidence indicating that contact between the coracoid and the humerus is possible, under normal conditions. I did not find such wear present in humeroscapular articulations in which the entire upper half of the articular capsule had been destroyed by use.

Anterior dislocation of the long head of the biceps must result in relaxation of the tendon for the interval between its two opposite points of attachment is decreased thereby. Hence there must be a reduction in the effectiveness of the contraction of the lateral portion of the muscle. However, it is possible that this relaxation of the tendon may in the

12. Meyer, A. W.: Unrecognized Occupational Destruction of the Tendon of the Long Head of the Biceps Brachii, Arch. Surg. **2**:130 (Jan.) 1921; Footnote 11.

13. Meyer, A. W.: Further Observations Upon Use-Destruction in Joints, J. Bone & Joint Surg. **4**:491 (July) 1922.

course of time be compensated for by greater contraction of its lateral belly, but it is doubtful whether such an adjustment occurs promptly. Hence the tendon would be more or less relaxed whenever the muscle is not active. It also follows that the shoulder joint must be weakened somewhat through such a displacement of the tendon of the biceps wholly apart from the weakening resulting from a loosening of the articular capsule in the injured region.

Since the migrating tendon presses against the joint capsule in the area of advance, it always lies in a capsular and retinacular sling. Moreover, as soon as it encounters the tendon of the subscapularis, it comes to lie on the latter. Because of these things and its protected position, the dislocated tendon is not subjected to attrition after it has reached its definitive position below and in front of the lesser tuberosity. This would be true, I think, even if it were subjected to the same tension as before, for it would tend to lie in the shortest line between its two attachments and hence remain protected. While it lies on the lesser tuberosity during transition or intermittently after dislocation it might, however, be subjected to decidedly more wear, but it certainly would not be absorbed.

I do not know how much pain and disability may accompany this dislocation, but it is more than likely that more or less discomfort is present and that a person so affected would protect the joint concerned by vicarious use of the other extremity, and thus save the yielding capsule or the displaced tendon.

In each of these four cases of dislocation it was easy to replace the tendon in the sulcus, but I doubt whether it would remain there in the living even if the detached capsule were sewed securely to the underlying bone, unless this procedure were accompanied by a change in occupation which not only made forcible contraction of the biceps unnecessary, but also obviated the movements responsible for the displacement. Surgical intervention, no doubt, would provoke bony proliferation and result in the formation of undesirable adhesions, and merely to sever the tendon seems wholly unjustifiable. It would seem that it should at least be attached in the region of the tuberosities where the spontaneously severed tendon so often becomes adherent.

Marked abduction of the upper extremity would continue to cause buckling of the joint capsule against the acromion as before, and would be accompanied by attrition as before. This, if excessive, would again lead to destruction of the new capsular attachment and to redislocation if not to destruction of it. These, however, are matters for surgeons, and I like to remember the old saying, let not the cobbler go beyond his last.

It must be evident that the shifting of the intact tendon of the long head of the biceps here reported is quite a different thing from the partial destruction of it and of the supraspinatus and subscapularis tendons accompanying some cases of complete destruction of the superior half of the humeroscapular capsule. However, both conditions apparently are due to use. The destruction of the tendon of the iliopsoas sometimes seen in connection with fracture of the neck of the femur with consequent upward displacement of the bone with resulting contact between the lesser trochanter and the tuberosity of the ischium also is due to wear, but not under normal conditions of the joint. I have seen destruction of the latter tendon also in a case of upward displacement of the acetabulum, or rather of a relocation of the acetabulum at a higher level on the ilium. However, these and other similar phenomena are quite different things from the dislocations of the uninjured tendon of the long head of the biceps brachii here under consideration, and only incidentally are occupational in origin.

An examination of several hundred humeri fails to reveal variations in the intertubercular sulcus or in the lesser tuberosity at all adequate to account for this surprising dislocation. Nor do I know of capsular anomalies responsible for it. It is not necessary that attrition against the acromion during abduction should first completely destroy or loosen the articular capsule in the region of the lesser tuberosity before this dislocation can begin, although such destruction was present in three of these four cases. In the other case, lesser attritional defects were present in the capsule only. The lesser tuberosity itself had not been materially affected.

The exact position of the dislocated tendon depends, to be sure, on the degree of displacement which it has undergone. When completely dislocated, that is, when the displacement has been maximum, the tendon extends downward and forward from its scapular attachment at the supraglenoid tubercle and the adjacent fibrocartilage. It lay closely against the anterior portion of the articular capsule in all four cases, and was entirely free from adhesions. It is highly probable that the synovial sheath that is carried forward with it, although greatly widened in the process of dislocation, is largely responsible for the absence of attritional effects on the tendon.

The fact that the tendon was not adherent and wholly preserved, even when the entire superior portion of the articular capsule was completely destroyed, shows conclusively that arthritic processes were not responsible for its dislocation. An arthritis, severe enough to destroy the entire thicker upper half of the articular capsule, and rarely also the tendon of the supraspinatus, certainly would not leave the tendon of the long head of the biceps or the thin inferior portion of the capsule intact. Yet

the latter was invariably the case. I have never seen this portion of the capsule affected in the least, no matter how amazing the destruction in its upper portion or how great the bony changes.

In regard to the genesis of this novel dislocation, it seems to me that it can be produced only after destruction of the superior portion of the articular capsule, and then only in the position of marked abduction and lateral rotation, facilitated, perhaps, by flexion of the forearm in the position of supination. Such conditions would produce a maximal relaxation of the tendon and permit it to be carried forward over the lesser tuberosity. Once dislocated it probably would always remain so, especially if continued attrition in the region of the tuberosities lead to bony proliferation and partial or total obliteration of them and of the intertubercular sulcus.

I have not, as yet, reviewed the published cases of rupture of this tendon, nor have I ever seen a case, but am prompted to suggest that weakening by attrition may be an important predisposing, if not an invariable, cause for this accident. It is evident that rupture of this tendon must have occurred in all cases in which I found it divided by friction, and in which it had not previously secured a firm secondary attachment in the region of the lesser tuberosity. Moreover, had any of these patients, or those with dislocation of the tendon here reported, sustained an injury of the shoulder, it would have seemed that this accident had produced the rupture or dislocation instead of merely furnishing circumstances that directed attention to the conditions.

PULMONARY COMPLICATIONS FOLLOWING ANESTHESIA AND OPERATION

A STATISTICAL STUDY *

I. S. RAVDIN, M.D.
AND
RICHARD A. KERN, M.D.
PHILADELPHIA

As a rule little consideration is given to the prevalence of respiratory infection in the community as an important factor in the incidence and the etiology of pulmonary complications after anesthesia and operation. An analysis of a series of such cases has impressed us with the importance of infection, especially epidemic respiratory infection, in the causation of these conditions and has prompted this report.

In the surgical division of the Hospital of the University of Pennsylvania during the last thirty-two months a study has been made of these conditions. As soon as a patient, after anesthesia and operation, is suspected of having a respiratory complication by the surgical house officer, a medical consultation is requested and the patient remains under the care of the medical consultant until the complication is terminated. Clinical findings are checked whenever possible by roentgen-ray examinations. On the basis of these observations an attempt has been made to evaluate the relative importance of the various etiologic factors in these conditions.

INCIDENCE

During the period from Sept. 1, 1922, to May 1, 1925, 5,966 operations were performed in the surgical service. This includes the departments of general surgery, neurosurgery and genito-urinary surgery. It does not include the departments of gynecology, obstetrics, otolaryngology, ophthalmology or the surgical outpatient clinic. In the 5,966 operations, sixty-nine respiratory complications after anesthesia occurred, an incidence of 1.15 per cent. An analysis of these complications is shown in table 1.

The diagnoses bronchopneumonia and lobar pneumonia, as is usual, comprise the majority, 61 per cent, in our series. The diagnosis in each instance was that made by the medical consultant and in twenty-nine of the sixty-nine cases was confirmed by roentgen-ray examination or necropsy or both.

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* From surgical division B and the medical division of the Hospital of the University of Pennsylvania,

ETIOLOGY

The contributing causes of postanesthetic, postoperative pulmonary complications have often been enumerated. They include a preexisting respiratory infection, acute or subacute, as met with so often in patients for emergency operation, or the various types of chronic respiratory disease, not omitting sinus infections; prolonged anesthesia; undue chilling of the body due to such factors as improper clothing and covering, delay in transport to and from the operating room in drafty hallways, excessive exposure in the operating room during the course of a prolonged operation, and a failure promptly to change moist garments; the aspiration of mucus and septic material; diaphragmatic paralysis following injudicious retraction in operations in the upper part of the abdomen; lung embolism, and finally, massive atelectasis due, according to Chevalier Jackson, to plugging of a main stem bronchus by inspissated mucus and the subsequent absorption of air from the distal lung.

We were interested to note that our sixty-nine cases of respiratory complications fell into two rather sharply defined groups. The larger,

TABLE 1.—*Analysis of Cases in Which Operations Were Performed*

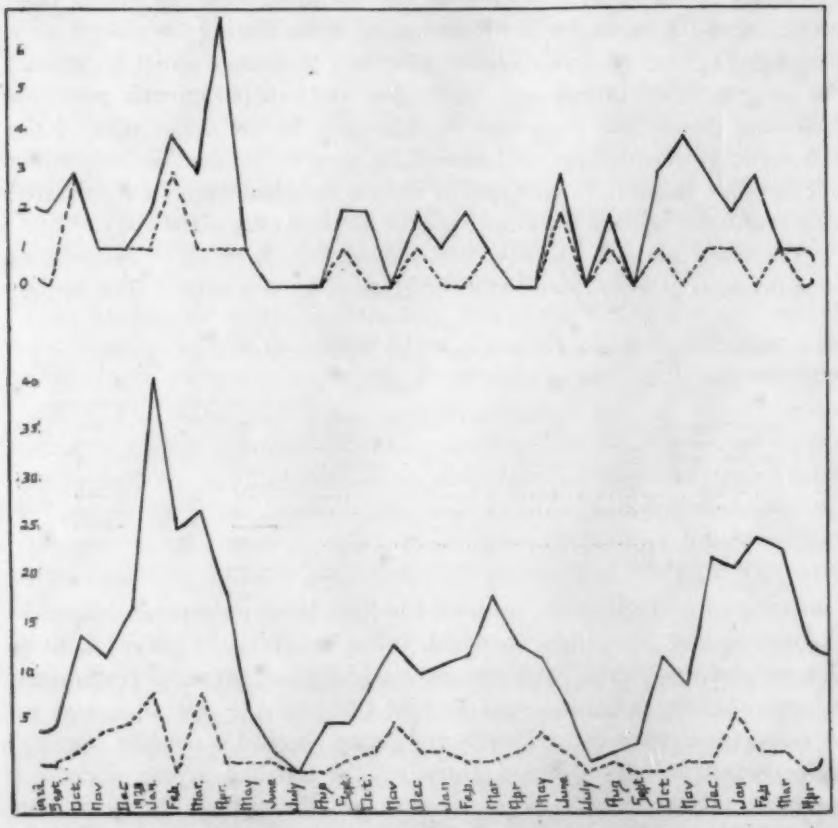
	Number of Cases	Percentage
Bronchopneumonia	22	31.9
Lobar pneumonia	20	28.9
Acute bronchitis	12	17.4
Hypostatic pneumonia	2	2.9
Embolism	11	16.0
Massive collapse	2	2.9
Total	69	100.0

consisting of fifty-six cases, presented lesions, lobar pneumonia, bronchopneumonia and bronchitis, in which infection certainly played a part. Fourteen of the fifty-six patients gave a history of an acute respiratory infection before operation, and in nine of these the operation was of an emergency character. This larger group showed a definite seasonal incidence, while the thirteen cases of the smaller group, including embolism and atelectasis, occurred scattered throughout the year with no suggestion of a seasonal variation.

In the accompanying chart the lower curves show the incidence of acute respiratory infection—pneumonia, tonsillitis, influenza and bronchitis—as observed in the medical division of the hospital during the period covered by this study. The solid line represents the total number of cases and the broken line the deaths. The upper curves illustrate the incident and the death rate in the surgical division of the group of postoperative, postanesthetic lobar pneumonia, bronchopneumonia and bronchitis. Because of the smaller number of cases in the surgical group the abscissa of the upper curves was made four times

greater than that of the lower in order to accentuate the variations. A rough parallelism between the two is readily seen.

It is probable that many of the patients admitted to a surgical service at a time when respiratory infections are prevalent in the community harbor the infectious organisms in their respiratory tracts. It is conceivable that any factor that lowers the patient's resistance, such as exposure or overfatigue, as well as the stress of operation and



Upper curves: postoperative respiratory complications in surgical division; lower: acute respiratory infections in medical division; solid line, cases: broken line, deaths.

anesthesia, might precipitate a pneumonia in such a person. Indeed, it has not been a rare occurrence to observe at such times the spontaneous development of pneumonia in patients who were being studied in the hospital preliminary to operation.

It would seem, therefore, that at a time when respiratory infection is epidemic in the community the surgeon should be conservative in recommending an operation of a nonemergency character, a precaution

that the nose and throat surgeon has long appreciated and observed. The patient should be observed in the hospital for several days before operation rather than be brought to operation immediately after admission. The presence of even a slight cold should be considered at such times a contraindication to anesthesia.

At such times, also, unusual precautions should be taken in the sterilization of the anesthetist's armamentarium, in the restriction of visitors, and in preventing physicians, nurses and attendants suffering with colds from coming in contact with the surgical patient. It is only necessary to refer to the 30 per cent mortality in the infectious group of respiratory complications to show the importance of these precautions.

The temperature records of the patients in this series were studied for possible information as to the factor of chilling. Eleven of the sixty-nine patients were returned from the operating room with a subnormal temperature, 97 F. or below, which persisted for from three to

TABLE 2.—*Incidence of Subnormal Temperature After Operation*

	Complicated	Uncomplicated
Total number of cases	69	120
Cases with subnormal temperature after operation	11	6
Percentage	16	5

TABLE 3.—*Sex and Ward Incidence*

Ward	Cases	Deaths
Men's ward 1	28	9
Men's ward 2	1	0
Women's ward	9	3

fifteen hours. These patients were not in a state of surgical shock so that this factor as a cause of subnormal temperature may be eliminated.

For comparison, the records of 120 operative cases having no respiratory complications were taken at random, ten cases from each month over the period of a year. Only six of these showed a subnormal temperature and it lasted six hours or less.

The surgical division has two men's wards and one women's ward. Men's Ward 1 and the women's ward have the same number of beds and are exactly alike in construction, having the same northern and eastern exposure, the one being situated immediately above the other in a new wing of the hospital. The number of patients treated per year in the women's ward is distinctly greater than that in the men's ward, yet the incidence of respiratory complications is three times greater among the men than among the women.

This striking difference in sex incidence is noteworthy. Various factors may play a part in its production. It is possible that women

have a higher natural immunity to respiratory infection (which someone has recently attributed to the "hardening" that women undergo as a result of modern dress). Because of their more sheltered existence it is also possible that they are less exposed to epidemic infections, and therefore are less likely to harbor the infectious organisms at the time of admission to the hospital. We have found no confirmation of the sex incidence in the literature.

Men's Ward 2 is situated in an older section of the hospital with a southern exposure and is flanked on the east and west by two wings that prevent the direct access of high winds. Its bed capacity is greater than that of either men's Ward 1 or the women's ward, but the number of patients in it per year is smaller. However, the type of patient in this ward presents a poorer surgical risk than those in the other wards, including, as it does, all septic cases. The small incidence in this more protected ward is therefore striking. It is worth considering in the planning of hospital contruction that in our striving for light and ventilation we may be unwittingly adding harmful exposure.

TABLE 4.—*Mortality*

	Number of Cases	Deaths	Percentage
I. Infectious group (pneumonia, etc.)	56	22	30.9
II. Embolism; collapse	13	6	46.1
Total	69	28	40.6

MORTALITY

The gravity of postanesthetic, postoperative pulmonary complications is obvious from the foregoing figures. We have attempted to determine some of the factors that play a part in this high death rate.

TABLE 5.—*Length of Anesthesia and Mortality*

Anesthesia	Recovered	Died	Per Cent
15 to 30 minutes	14	2	14.3
31 to 90 minutes	28	13	46.4
91 to 240 minutes	7	5	71.4

The danger of prolonged anesthesia, well known as it is, needs nevertheless to be constantly emphasized. Our figures show a distinct increase in the mortality of the complicated cases in direct proportion to the duration of the anesthesia.

TABLE 6.—*Age-Mortality Incidence*

Age	Cases	Deaths	Per Cent
From 1 to 20	7	2	28.5
From 21 to 40	30	12	40.0
From 41 to 60	23	8	34.7
61 plus	9	6	66.7

There is little variation in the death rate in patients under the age of sixty. In the older patients, as might have been expected, the mortality is high.

TABLE 7.—*Anesthetics Used and Mortality*

Anesthetic	Cases	Deaths
Local	8	5
Gas—local	3	2
Gas	7	3
Gas—ether	13	2
Ether	24	10
Spinal	1	0

Our series is entirely too small to draw any conclusions as to the relative dangers of the types of anesthetic agent. However, in the infectious group of the complicated cases, gas-ether anesthesia carried a mortality well below the others, while local anesthesia had a surprisingly high death rate.

SUMMARY

The importance of the prevalence of acute respiratory infection in the community as an etiologic factor in postanesthetic, postoperative complications is emphasized. Attention is called also to the greater incidence of such conditions in men and to the possible part played by hospital ward construction and by chilling of the patient during operation. Prolonged anesthesia and advanced age both definitely increase the mortality.

A REVIEW OF UROLOGIC SURGERY

ALBERT J. SCHOLL, M.D.
LOS ANGELES
E. STARR JUDD, M.D.
ROCHESTER, MINN.
LINWOOD D. KEYSER, M.D.
ROANOKE, VA.
GORDON S. FOULDS, M.D.
TORONTO
AND
JEAN VERBRUGGE, M.D.
ANTWERP, BELGIUM

Progress in Urology.—Braasch [1] reviews the recent progress in urology. He states that most of the present methods of treatment of submucous or Hunner's ulcers of the bladder are unsatisfactory. Surgical excision is frequently followed by recurrence. Various forms of lavage and topical applications also prove to be disappointing. Cauterization and fulguration frequently afford relief but not necessarily permanent cure. Braasch feels that alteration of the reaction of the urine deserves further study. He also considers the present views on the treatment of ureteral calculus and the indications for operation or cystoscopic manipulation and concludes by saying: "When a surgeon is available who has the ability to carry out either procedure, ureterolithotomy, which is attended by little or no mortality, and usually delays the patient but two or three weeks, is often to be preferred to the frequently tedious attempts at manipulative methods." Radium, in Braasch's estimation, has not proved as satisfactory in the treatment of carcinoma of the prostate and tumors of the bladder as it once was thought to be. A proper gradation of the malignancy of a vesical tumor and close observation of the patient following treatment will do much to standardize our methods of treatment.

In considering ureteral stricture, he does not look with favor on the indiscriminate dilatation of the ureter in all cases of vague abdominal pain, but in cases in which a stricture can be definitely shown by the urogram, he considers it to be a proper procedure.

Mercurochrome for intravenous use is found most beneficial in the more acute infections of the urinary tract and less so in chronic and gonorrheal infections. He considers the use of hexylresorcinol as still in the experimental stage.

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1. Braasch, W. F.: A Review of Recent Progress in Urology, J. Urol. **14**: 183-192 (Aug.) 1925.

KIDNEY

Surgical Technic.—Rosenstein,[2] after reviewing in a critical manner the advantages and disadvantages of the various extraperitoneal approaches to the kidney, advocates an incision that begins 8 cm. laterally from the spinous process of the first lumbar vertebra and extends to a point 14 cm. back from the anterior superior spine of the ilium. Cutting through the underlying latissimus dorsi and superficial lumbodorsal fascia brings the operator to the lumbar triangle (Spatium tendineum lumbale) bounded anteriorly by the muscles of the abdominal wall and posteriorly and above by the iliocostal and serratus posticus inferior. The floor of this triangle containing the deep lumbar fascia is incised, exposing the fatty capsule of the kidney. The incision is extended up to the last rib. The last intercostal arteries and nerves and the ilioinguinal and iliohypogastric nerves are drawn aside, the latter toward the iliocostal muscle. By incision of the fatty capsule of the kidney the latter is easily exposed. In cases in which there is too small a space between the last rib and the iliac crest, resection of the last rib to give better exposure is recommended.

[ED. NOTE.—The incision, which is based on a muscle-splitting principle, would seem to be a good one. It is a question, however, whether its advantages are really greater than that of the Mayo or posterolateral incision so widely coming into use in this country. The division of the lumbar muscles for exposure of the kidney is followed by prompt healing, and hernia through such incision is a rare occurrence.]

Alcock[3] says that any procedure in extreme cases is justified if it improves the patient's condition more than it increases the difficulties of nephrectomy. The division of nephrectomy into two stages is indicated in only a small proportion of cases. When carried out, it is a procedure not infrequently forced on the surgeon after he has tried to perform primary nephrectomy. There are two definite surgical procedures advocated in two-stage nephrectomy: one is ligation of the renal pedicle transabdominally; the second is preliminary nephrostomy for drainage. The latter is at times necessary on account of difficulties which may arise during the course of an attempted primary nephrectomy. Chute divides the cases of secondary nephrectomy into two groups: the first is made up of those cases in which the operation was intentional, and in his series of twenty, nine fell into this group; the second comprises those cases in which the operation was forced on the operator, either by difficulties arising at the time of operation, or by

2. Rosenstein, Paul: Ein funktioneller Lumbalschnitt zur Freilegung der Niere, Ztschr. f. urol. Chir. **17**:119-126, 1925.

3. Alcock, N. G.: A Few Cases of Two-Step Nephrectomies, J. Urol. **14**: 239-248 (Sept.) 1925.

errors of some sort either in diagnosis or judgment. He feels that two-stage nephrectomy in a very limited group of cases of renal infection is life saving. He brings out many valuable points in the technic, such as the inclusion of the sinus in the second incision, the necessity of freeing the kidney posteriorly first, the care to be taken in the reflection of the peritoneum, and the difficulties met with in dealing with the renal pedicle. In dealing wtih the pedicle he prefers, if possible, to ligate the entire pedicle before a clamp is put on, and then to follow this with the reinforced ligatures. He says that the preliminary nephrostomy makes the secondary nephrectomy more difficult, and that the difficulty is increased by the time that elapses between the first and the second operation. Alcock has performed preliminary nephrostomy in fifteen cases, and secondary nephrectomy in two. In one case, preliminary drainage had been carried out by another surgeon. In one series of ten cases, in which two-stage nephrectomy was premeditated, there were four cases of renal tuberculosis, two cases of pyonephrosis and four cases of hydronephrosis associated with infection. All these patients were in bad condition and preliminary drainage by catheter had been attempted. Two of the patients with tuberculosis never reached the second operation. In four of the remaining eight cases the kidney was removed. The other four patients are now in the interval between the two operations. Improvement of the general condition after the preliminary operation usually is very marked.

The removal of the kidney usually is not difficult and there is no greater loss of blood than would occur with primary nephrectomy. In five cases Alcock started with the intention of performing primary nephrectomy and either met with difficulty during the first operation or the patient's general condition became so serious that continuation of the operation was undesirable. Drainage of the kidney was effected in these cases. In two cases of renal tuberculosis in which nephrostomy was performed the general health of the patient was so much improved that consent to the second operation was refused. Alcock believes from the study of these cases that nephrostomy, as a preliminary step to nephrectomy in cases of infection of the kidney, is clearly indicated in a small group of cases. Preliminary nephrostomy makes the freeing of the kidney more difficult, but the decrease in the size of the kidney, the improvement in the patient's general condition and the decrease in the tendency to hemorrhage compensate for the increased difficulty. The sinus, if possible, should be included in the second incision. The kidney should be freed posteriorly first, and then around the lower pole, and the greatest care is necessary in reflecting the peritoneum. It is safest, if possible, to ligate the pedicle with one ligature before clamps are put on. After that, any further procedures possible in controlling the hemorrhage from the pedicle are to be recommended.

Alcock puts on a primary ligature first, then a clamp and then cuts off the pedicle as near to the kidney and as far away from the clamp as possible. The individual vessels that protrude from the clamp are then ligated. A transfixed ligature, or a mass ligature is then put on back of the clamp; the ligature is tied as the clamp is removed. In these cases of secondary nephrectomy infection of the wound almost invariably occurs but rarely causes much trouble.

Crosbie [4] believes that a kidney should never be opened for any cause whatsoever without leaving drainage to the renal pelvis. For this he prefers a rubber tube. It is impossible to open a kidney and then close it without blood clots accumulating in the pelvis. If infection is present, as is nearly always the case in the presence of calculus, drainage is of especial importance. Crosbie carries out simple nephrostomy as follows: The kidney is grasped firmly in the left hand with the fingers in contact with the renal pelvis. A nick is made through the capsule at the junction of the middle and lower thirds, just posterior to the median line. A closed half-length clamp is then inserted until the end can be felt in the pelvis, by the fingers of the left hand. The clamp is removed and either the little finger or forefinger of the right hand is introduced into the renal pelvis. Following this a rubber tube, about five-sixteenth inch (0.78 cm.) in diameter, is passed to the pelvis. The bleeding at first is rather profuse, but generally subsides quickly after the tube is in place and the kidney is dropped back into position. If the bleeding persists enough to be alarming a deep catgut suture can be placed on either side of the tube and tied gently, or a wisp of gauze may be packed in alongside the tube. The length of time that the tubing remains in place depends entirely on the nature of the case. Provided there is no obstruction to the ureter the nephrostomy wound heals readily. Double nephrostomy gives satisfactory relief in cases of double chronic pyelonephritis with megalo-ureter. In cases of long standing unexplained renal hematuria, Crosbie prefers to perform nephrostomy in addition to decapsulation. Nephrostomy is undesirable in cases of renal tuberculosis as the wound always becomes infected and the danger of disseminating the disease is great.

Cifuentes,[5] in certain cases of suppurative disease of the kidney, in which ureteral catheterization is impossible, suggests a ureteral compression test together with a provoked elimination, or a double lumbar exploration. Lumbar exploration should be made only in cases in which the elimination of phenolsulphonphthalein is satisfactory. It is advisable in making a double exploration to operate on the supposed

4. Crosbie, A. H.: The Rôle of Nephrostomy in Genito-Urinary Surgery, J. Urol. **14**:249-252 (Sept.) 1925.

5. Cifuentes: Contribution à l'étude de l'exploration sanglante du rein, Presse méd. **2**:1461-1462, 1925.

healthy kidney first. If no lesions are visible, urine should be collected by puncturing the renal pelvis, thus ruling out the possibility of infection. If the diseased kidney is exposed first the wound should be momentarily packed and the other side explored. This operation may be performed in either one or two stages, depending on the patient's condition. In exploration of kidneys in which the condition was unknown Cifuentes performed ureterotomy in seven cases. In four the exploration was unilateral: in two of these nephrectomy was performed, followed by death in one case. In three cases bilateral exploration was carried out; bilateral lesions were present in all and death occurred in all. Bilateral exploration of the kidneys was carried out in eighteen cases, in fifteen of which nephrectomy was performed; death occurred in one case, and cures followed in fourteen.

Nephrolithiasis.—Jean [6] reports the case of a young man who had suffered from pain in the right side of the abdomen, hematuria and frequency for three years. Appendectomy had not changed his condition. Roentgenograms revealed a large shadow which was interpreted as an enlarged kidney. Ureteral catheters were passed up to a point 24 cm. above the orifices on both sides; 80 cc. of urine was obtained from the right renal pelvis, the last drops being thick pus containing staphylococci; the urine from the left side was normal. A diagnosis of right uronephrosis with infection was made. At operation it was impossible to locate the kidney through the usual lumbar incision. The incision was then prolonged to the right iliac fossa where an enlarged kidney was found, firmly adherent to the surrounding organs. Its anterior surface was lying against the posterior surface of the bladder; its external border was in contact with the right common iliac vein; its internal border was adherent to the rectum. No suprarenal body was found. The kidney was removed and the patient recovered uneventfully. Pathologic examination showed a pyonephrotic kidney with a stone 1 cm. in diameter in one of the calices near the hilum. This variety of anomaly is rare; only about fifty cases have been reported. Jean says that hydronephrosis is quite common in ectopic kidneys; the proximity to infected organs is probably the cause of the infection; lithiasis occasionally occurs; errors of diagnosis are numerous. He believes that the diagnosis should have been made in his case on account of the presence of an atrophic testis, but he was misled by the roentgenogram and by the fact that the ureteral sound had been passed up to at least 24 cm., whereas the ureter was only 6 cm. in length on the affected side. He deduces from this experience that a roentgenogram of the whole urinary tract and a pyelogram should be taken in all such suspected cases.

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6. Jean, G.: Uropyonéphrose et lithiase d'un rein en ectopic iléo-pelvienne, J. d'urol. méd. et chir. **19**:136-139, 1925.

Boeckel [7] reports the case of a woman for whom, twenty months previous to admission, right pelviolithotomy had been performed, followed a year later by a left pelviolithotomy. Five months after this there was a recurrence of stone on the left side. Pain was severe and persistent, and the left kidney was again operated on. This was preceded by lavage of the renal pelvis. Five days after operation the patient died from renal insufficiency. At necropsy slight parenchymatous nephritis was found. Most of the authors who report similar cases attribute the death to preexisting nephritis, postoperative acute nephritis, or else to a certain "renal fragility" impossible to foresee. Boeckel concludes that this question is far from being solved and necessitates investigation.

Thomas [8] reports a series of seventeen cases of bilateral formation of renal stone. In 66 per cent infection was present. Such patients are commonly called "stone formers." The majority of patients had no symptoms referable to the kidneys. Thirty per cent of the number studied were operated on without permanent relief, that is, the stones recurred. In cases in which relief followed operation there were single small stones which were free in the renal pelvis or at the ureteropelvic juncture. In these instances, little or no infection was found in the kidneys. In few instances did this removal of foci of infection together with pelvic lavage, permanently control the infection in the pelvis or the kidney. The infection might be controlled temporarily but recurrence with formation of more stones was the rule. Bilateral stones occurred in one child of 16 months. After operation on both sides stones recurred. Thomas advocates complete urologic study of infants and children having pus in the urine. This must include roentgenograms of the entire urinary tract. In infants and children about 6 per cent of renal stones are bilateral.

Papin [9] states that it is important in cases of renal lithiasis to make complete roentgenograms of the urinary tract. He also emphasizes the utility of nephrostomy in some cases in which nephrectomy is often performed. He illustrates these suggestions by a case of his in which a patient exhibiting definite symptoms of lithiasis of the left kidney, without any complaint whatever referable to the right side, was shown by roentgenogram to have numerous stones of various dimensions on the right and only two small stones on the left. Double nephrostomy

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7. Boeckel, André: Nephrolithiase double pyélotomie: Récidive à gauche functionnement suffisant du rein droit: Néphrectomie secondaire gauche: mort par insuffisance rénale, J. d'urol. méd. et chir. **20**:78-81, 1925.

8. Thomas, G. J.: Bilateral Renal Lithiasis, J. Urol. **14**:501-507 (Nov.) 1925.

9. Papin, Marc: Considérations sur un cas de lithiase rénale bilaterale operée par nephrotomie double, J. d'urol. méd. et chir. **20**:73-78, 1925.

led to a perfect recovery without any subsequent fistulas and with satisfactory final function of both kidneys.

Renal Neoplasm.—Cabot [10] states that the incision or incisions for the exposure of renal tumors must give free access and handicap the surgeon as little as is compatible with a decent respect for anatomic structures. The incision must also allow a wide exposure of the perirenal structures because in many, if not most, of the cases it will be necessary to deal with something more than the kidney itself. The surgeon should do his work with as little permanent damage as possible. Damage to the nerve supply, particularly in the case of operations involving divisions of the abdominal wall, is to be avoided if possible. Division of muscular structures, though it often looks serious and gives the impression of radicalism, is not so in fact. Muscular structures unite with fibrous tissue giving a scar of satisfactory firmness and doing little damage to the general integrity of the abdominal wall. The classical oblique incision ordinarily begins at about the anterior border of the erector group of lumbar muscles and extends forward and downward just below and, in general, parallel with the twelfth rib. It is possible to extend this incision forward and inward to almost any extent. This incision avoids damage to large nerve trunks and has been eminently satisfactory for a large majority of the problems presented in renal surgery. In the case of renal tumors, however, it does not give quite satisfactory access to the tumor. In many of these cases the mass is situated relatively high under the diaphragm. It is necessary to remove not only the kidney itself but also its fat capsule, a requirement that does not obtain in other operations on the kidney. The most important defect of this incision, however, appears to lie in the relatively poor access that it gives to the renal pedicle. In operations on tumors of the kidney, hemorrhage is the greatest factor in the mortality. Inability to control bleeding satisfactorily is likely to result from a cramped approach, and in this case Cabot believes that the common use of this incision is an important factor in the still too high mortality in this group of cases. The anterior oblique incision starts relatively farther forward than the classical incision and is continued downward and mesially from a point in about the midaxillary line parallel with the direction of the fibers of the external oblique. It is satisfactory from the point of view of moderate damage to structure and avoidance of the most important nerve trunks. This incision gives relatively poor access to the tumor. It may also damage nervous structures if it is made of thoroughly sufficient length. The nerve-supply of the rectus muscle turns sharply inward and is likely to be divided with the effect of producing more or less paralysis of this structure.

10. Cabot, Hugh: The Operative Approach for Malignant Tumors of the Kidney, J. Urol. **14**:261-267 (Sept.) 1925.

A third type of incision which Cabot describes is the umbilical: a vertical incision through or at the outer border of the rectus muscle combined with a transverse incision about the level of the umbilicus. This incision gives satisfactory access but is undesirable on account of the inevitable damage to the nerve supply of the rectus muscle. If made of sufficient length to give thoroughly good access, it will be likely to paralyze the greater part of the rectus muscle. The transverse portion of this incision is largely free from objection but its vertical limb is highly damaging. The high transverse incision with cross cutting of the last rib is rarely used, as the vertical portion damages nervous structures. Cabot draws particular attention to a combination of the transverse incision with a vertical incision in the median line. The incision should be started well back in the loin near the anterior border of the erector group. It should be planned to pass not far from the lower border of the twelfth rib, inclining slightly downward until it reaches the median line in the region of the umbilicus. The course of this incision does not traverse any nerve trunks of importance and will not result in paralysis of the rectus or of any important amount of the oblique muscles. It is then met by an incision in the median line carried upward to any necessary extent. This does not damage the nerve supply or other important structure. It allows the raising of a triangular flap which gives direct access to all of the structures of the upper quadrant. Through this incision the costal margin may be lifted as freely as is ordinarily necessary. The peritoneum is lifted from the posterior wall, carrying with it the colon and its mesentery which may be turned inward as far as the median line. This flap of peritoneum with its intestinal and mesenteric content has the effect of keeping the other intestines out of the way and gives a wholly satisfactory view of the field. Cabot believes that this is the least damaging and most satisfactory of all incisions of this type. It is possible to control all the blood supply satisfactorily, especially in the approach to malignant tumors.

Beyer [11] states that nephrectomy is the only treatment for renal tumors. Recurrence usually occurs in the scar, more rarely by metastasis. In more than half the cases recurrence appears during the first year after operation. About 15 per cent of the patients may expect a permanent cure; 11 per cent of Beyer's patients were cured. Neither the study of the general or local condition of the patient nor the histologic nature of the tumor can give any definite deduction so far as the prognosis is concerned. Extensive adhesions constitute a unfavorable prognosis. In the discussion of this report, Marion insists on the need

11. Beyer: Diagnostic et traitement des tumeurs du rein, Bruxelles méd., 1925, pp. 386-388.

of early diagnosis and cites unilateral hematuria as one of the most important symptons. He also prefers the lumbar incision with resection of the twelfth rib if necessary. He does not rely on radiotherapy. Chevassu, confirming the foregoing, desires a routine roentgen-ray examination of the chest in order to eliminate pulmonary metastasis, which would be a contraindication to operation. Of ten patients on whom Chevassu performed nephrectomy for renal tumors, one died and several others had recurrences.

Hyman [12] reports a series of seventy cases of renal tumors: forty-four of hypernephroma. Sixty patients were adults and ten were young children under nine years. Fifty were males. More than half of these cases occurred during the fourth and fifth decades. The right kidney was diseased in thirty-eight cases, the left in thirty-two. Calculi were found in three cases. In one of these malignancy was not suspected, a diagnosis of calculus having been established. At operation a suspicious looking area in the cortex was discovered, and on microscopic examination proved to be adenocarcinoma. Hematuria was the first symptom of twenty-one of sixty adult patients. Nine patients had had the initial hematuria within six days whereas the majority had had it weeks, months and even years before. Pain, as an initial symptom, was present in eighteen cases, and not infrequently antedated the appearance of hematuria by many months, and in a few cases, years. Hematuria was the predominating symptom, from a diagnostic point of view as it served to direct the notice of the patient and physician to the urinary tract as the seat of the trouble. The bleeding in some cases was profuse. It may be only microscopic for a long time, before a macroscopic hemorrhage takes place. It is generally painless except where blood clots are passed. Twelve patients (20 per cent) had metastasis when first observed. The points of predilection for secondary deposits are the lungs, long bones, liver and brain. Involvement of the retroperitoneal glands in the region of the kidney was found four times in sixty cases, three times with carcinoma, once with hypernephroma. In children tumors of the kidney have different characteristics from those in adults. The first symptom in many cases is the presence of a large abdominal mass which may sometimes become enormous. The child may appear quite well.

In all cases of renal tumors the one recognizable form of treatment is nephrectomy; radium and deep roentgen-ray treatment are to be used only as adjuvants. Deep roentgen-ray treatment may be of value in inoperable cases for controlling hematuria. In the series of cases in adults there were forty-two in which lumbar nephrectomy and five in

12. Hyman, Abraham: Clinical and Surgical Aspects of Renal Neoplasms, Surg. Gynec. Obst. **41**:298-310 (Sept.) 1925.

which transperitoneal nephrectomy were performed, the latter being reserved for very large growths. Besides the usual oblique incision, a transverse lumbar incision has been recommended, dividing, if necessary, one rectus muscle. This incision gives a very good exposure. If a question arises as to the operability of a case, it is advisable to open the peritoneum and examine the liver for metastasis. The renal vein should be ligated as early in the operation as possible to prevent tumor cells from being squeezed into the general circulation. It is important to excise entirely the fatty capsule of the kidney. With transperitoneal nephrectomy there is a higher mortality because peritoneum is opened and there is usually more extensive involvement. In twenty cases the growth had extended into the renal vein; in a few it had extended into the vena cava. This condition does not necessarily make the prognosis more grave. Ten patients in this series with involvement of the renal vein have survived operation for from one to five years. The prognosis in general is bad, death occurring from recurrence, cachexia or metastasis, often as late as ten years after operation. The percentage of three year cures average 20 to 30, and five year cures probably less than 15. The ultimate mortality rate is between 65 and 75 per cent. To reduce this high rate cystoscopy and pyelography should be practiced, not alone in cases of hematuria, but in every case of unexplainable lumbar pain. Patients complaining of intractable sciatica and lumbago should be examined more carefully.

Ed. Note—Hyman's experience with renal tumors is, in general, similar to that reported from the Mayo Clinic, where hematuria as the first symptom was noted in almost 40 per cent of the cases. The appalling feature of this hematuria was that it had been allowed to continue, intermittently, on an average for almost two years before the patient was referred for urologic investigation and surgical treatment. This is, indeed, a grave reflection on our profession as a whole. It is principally by seeing patients early in the disease that we may hope to improve our results in the treatment of renal neoplasms.

In the matter of prognosis we have found the microscopic grouping of these tumors to be a great help, as in cases of malignant cystadenoma. From one to five years after nephrectomy the proportion of living to dead was 2:1; in cases of papillary carcinoma with clear cells (typical so-called hypernephroma) 1:1; in cases of papillary adenocarcinoma with granular cells 1:3; and in cases of alveolar carcinoma 1:7. The greatest single factor in disturbing this ratio was the involvement of the renal vein with tumor tissue in the papillary carcinoma with clear cells. When this occurs the prognosis is generally bad although in all large series of cases exceptions are to be found in which patients with undoubted venous involvement have survived as long as fourteen years.

In our series we had two patients who survived twelve and fourteen years, respectively, and Albrecht [13] reports the case of one patient who lived twelve years.]

Smith [14] studied sixty-two cases of hypernephroma treated at the Massachusetts General Hospital over a period of twenty-three years. In fifty-two of the cases finally accepted the diagnosis was verified by the pathologist. Thirty-four, or more than half the patients, were between 40 and 60 years, and the patients of from 51 to 60 years were more than twice as numerous as those in any other decade. Forty-three were males, nineteen were females. The right kidney was primarily involved in twenty-seven, the left in twenty-five. In one case both suprarenals contained hypernephromas of approximately equal size. There was hematuria in twenty-seven of the sixty-two cases; in thirty-two none. Pain was noted as being present in thirty-two cases, and absent in twenty-six. The most consistent finding was that of tumor. An enlarged kidney was found in forty-eight cases; in a number of instances the patient himself had noticed the mass. In only one of the twenty-six cases in which nephrectomy was performed was it stated that no tumor was felt. In two other cases no mention of tumor was made. The early occurrence of hematuria is a favorable factor, as it alarms the patient. The value of hematuria as a warning is demonstrated by the fact that in 61 per cent of the twenty-six cases considered suitable for nephrectomy there was hematuria, whereas in only 43 per cent of the entire series was there blood in the urine. Pyelograms were made in ten cases, in all of which malignancy was indicated. The earliest pyelogram was made in 1916; the earliest divided function, by phenolsulphonphthalein, in 1911. There were four operative deaths in the twenty-seven cases; one patient died from embolus during the operation; one, on whom a transperitoneal nephrectomy was performed, died from peritonitis five days after the operation; one died from pneumonia one month after operation, and one from shock a few hours after operation. Eight of the remaining twenty-three patients died within a year, six from extension of the growth, two from unknown cause, possibly from malignancy. Four patients lived three, five, ten and twelve years without signs of recurrence; one patient lived four years, two lived eight years and died from the malignancy. In the entire series results were known to be favorable in nine cases. Of the twenty-seven cases of nephrectomy results were unknown in six. One case, that of a man aged 34, was examined for tumor of the

13. Albrecht, Paul: Beiträge zur Klinik und pathologischen Anatomie der malignen Hypernephrome, Arch.f. klin. Chir. **77**:1073-1170, 1905.

14. Smith, G. G., and Schoemaker, A. B.: The End-Result of Hypernephroma, J. Urol. **14**:389-402 (Oct.) 1925.

upper arm, which was amputated. The patient lived for five years. A review of thirty-four inoperable cases showed that ten patients died the first six months after leaving the hospital and a second series of ten died from six to twelve months afterward. Two patients died the following year and three lived from four to seven years. In one case in which necropsy was performed there was hypernephroma of the left kidney and papillary adenoma of the right.

Renal Tuberculosis.—Freudenberg [15] states that tuberculosis of the kidney, usually being unilateral, may affect the mobility of the bladder on the diseased side in such a way as to produce filling defects and distortion of the outlet in the cystogram; this may be of diagnostic value. For instance, the distance of the lateral margin of the bladder from the median line is less on the diseased side. Frequently there is a sharper sloping level in the contour of the diseased side in contrast to the rounded outline on the other. By filling the bladder slowly, while the patient lies absolutely quiet, several exposures may be made. Lagging or failure of the filling out of one side, as the contrast fluid is introduced, may be of significance. This method is thought to be of value usually in cases of late unilateral tuberculosis in which the sensitiveness or small capacity of the bladder makes proper cystoscopic technic difficult. If the ureter in the female is palpable by vagina and the cystogram shows the abnormalities just mentioned, the evidence for tuberculosis on that side is fairly conclusive. With healing of the bladder subsequent to nephrectomy for tuberculosis, there is a corresponding tendency for these roentgenologic findings to approach the normal again in varying degree.

[Ed. Note.—Undoubtedly the study made is of confirmatory diagnostic importance in cases of renal tuberculosis. As Freudenberg points out, the technic of taking the roentgenogram must be carefully executed, as slight changes in the position of the patient, plate or tube may cause an angular irradiation and give a false impression. Probably there are cases, such as the one mentioned by Freudenberg, in which the diagnosis may be safely assumed from such roentgenologic findings. However, it is equally probable that in most instances one could not always attribute the filling defects on one side entirely to tuberculosis. Extravesical growths, intravesical tumor and the like would have to be excluded. Not infrequently, in cases in which the infection of one kidney has progressed to the extent that the corresponding segment of the bladder is extensively diseased, the opposite kidney also is tuberculous. Before operative measures are contemplated, more complete proof is necessary that the lesion is unilateral.]

15. Freudenberg, Albert: Ein röentgenologisches Symptom bei Nierentuberkulose, Ztschr. f. urol. Chir. **16**:187-193, 1924.

Berard [16] reports the case of a man with a large abscess of the iliac region, which prevented him from walking comfortably and was apparently due to Pott's disease There had been few symptoms of any kind during the previous year except that from time to time, at the end of micturition, a few drops of pure blood appeared which caused a burning sensation in the urethra. The urine did not contain pus. A mass had appeared a month before admission. It was situated below the anterosuperior iliac spine and above Poupart's ligament; it was elongated, fairly hard and painful on pressure. There was no pain on percussion of the spine. The mass extended as high as the lumbar region and could be felt by bimanual palpation. The genital organs were normal and the examination of the urine was negative. The cystoscopic examination was performed with some difficulty; the prostatic urethra was partially obstructed. The vesical neck and interureteral regions were uniformly and intensely red; the ureteral orifices were difficult to find; bleeding occurred constantly; there were no granulations. At operation, Berard, using an oblique costo-iliac incision, found a voluminous irregularly shaped kidney, which accidentally ruptured in one area, freeing caseous pus. Nephrectomy and partial uterectomy were performed. The iliac abscess was incised; it was found to be deep, but could not be connected with any organ and probably was of periureteral origin. Good postoperative results and cure followed, but a small iliac fistula with very little discharge remained. A second cystoscopic examination revealed a large right ureteral orifice, surrounded by an area of congestion, without ulceration or granulation. Berard was in doubt whether he should leave the patient to his general hygienic treatment for tuberculosis or resect the remaining ureteral stump transperitoneally.

Papin [17] reports the case of a young man, belonging to a hemophilic family, exhibiting marked hematuria without any evident vesical or abdominal symptoms or signs. The output of urea was slightly lowered but the urine tests on catheterized specimens were negative, the urine being perfectly clear between spells of hematuria. Papin was compelled to perform nephrectomy on account of the excessive hemorrhage. A large bluish red kidney, containing a few fine granulations but surrounded by a perfectly normal capsule, was extirpated. The surgical-pathologic diagnosis was tuberculosis. A small vessel had been eroded and almost occluded by a thin coat of fibrin. This may have been the source of hematuria, along with the hemophilic constitution of the patient. Death took place suddenly following embolism.

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16. Berard: Sur une forme assez rare de la tuberculose génito-urinaire: Gros rein droit caséeux fermé: Volumineux foyer de périuretérite suppurée, simulant un abcès froid pottique au-dessus de l'arcade de fallope, Lyon chir. **21**:769-771, 1924.

17. Papin, Marc: Tuberculose rénale unilatèrale à symptomatologie uniquement hémorrhagique chez un hèmophile, J. d'urol. méd. et chir. **20**:69-72, 1925.

Blanc [18] examined a young woman with advanced tuberculosis of the left kidney. The cystoscopic examination revealed a double ureteral orifice on the right side. The urine from one of the halves of the right kidney also indicated tuberculosis. Pyelograms taken with two different catheters revealed that the superior pelvis corresponded to the superior orifice in the bladder and the inferior pelvis to the inferior orifice. The superior half had a small pelvis and appeared to be atrophic; the inferior one, larger in size, was thought to be tuberculous. The phenolsulphonphthalein return was good from both renal segments. Left nephrectomy was performed. The upper right atrophic kidney as well as the infected lower one compensated very well, and three months after operation the phenolsulphonphthalein return was 60 per cent. Blanc stated that in cases of double ureter one should always determine which kidney corresponds to each ureteral orifice by a pyelogram taken with two catheters. The functional value of a kidney does not always correspond to the amount of parenchymatous tissue, and a small pelvis does not necessarily indicate an atrophic kidney. A small apparently atrophic kidney may be capable of an unexpected hyperfunction. When a renal mass is composed of two separate unequal segments, the smaller superior portion does not always correspond to the diseased area. A slightly infected tuberculous kidney may show considerable compensatory hypertrophy after the removal of the more seriously infected opposite kidney. With the aid of the phenolsulphonphthalein functional test, one may follow step by step the development of the functional activity of a kidney and its progressive hypertrophy.

[ED. NOTE.—This case is interesting in that the relationship between the ureteral orifices and the renal segments is opposite to that usually found in cases of double kidney. When two ureteral buds are present, as the result of changes in the position of the duct and the rotation and ascent of the two renal segments, it generally develops that the lower ureteral orifice drains the upper kidney. Papin reported a case of bilateral tuberculosis in which the left kidney was partially resected; later right nephrectomy was performed. No report on the later results of Papin's case was obtainable. It would also be interesting to know the late results in Blanc's case. Braasch has shown that improvement is generally noted in other tuberculous foci after the removal of a tuberculous kidney. This is more marked when there is a focus in the lungs or joints. Hinman has shown that in the case of partially destroyed kidneys the return of function in the remaining kidney is at times prompt after excision of the opposite kidney.]

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18. Blanc, H.: A propos d'une tuberculose rénale gauche avec duplicité complète de l'uretère du rein droit, J. d'urol. méd. et chir. **20**:47-57, 1925.

Persson [19] presents a clinical study of renal tuberculosis at the surgical clinics of the Seraphimer Hospital, Stockholm, during the period from 1890 to 1920. There were 295 patients; 194 (65.8 per cent) were men, and 101 (34.2 per cent) were women. Operation was performed in 205 cases and in ninety it was not. In five cases the disease occurred in the first ten years of life, in four cases the age was more than 60, and in 227 cases it was between 30 and 60. Symptoms of other tuberculous lesions occurred in about half the cases as follows: pulmonary tuberculosis, sixty-six cases (22.4 per cent); genital tuberculosis (male), forty-six cases (15.6 per cent); tuberculosis of bones and joints, twenty-one cases (7.1 per cent); pleuritis,

TABLE 1.—*Operative Mortality and Relation of Mortality to Age of Patients in One Hundred and Ninety Cases of Nephrectomy for Unilateral Tuberculosis*

Patients who died from six to eighteen years after operation	16	
Operations for unilateral renal tuberculosis	190	
Operative mortality	14	(7.3%)
Patients with complete postoperative data	182	
Patients who died after dismissal from the hospital	45	(24.7%)
Patients who died within three years after operation	21	
Patients who died more than three years after operation	24	
Patients who died from one to five years after operation	29	
Patients who died from six to eighteen years after operation	16	
KNOWN CAUSES OF DEATH IN FORTY-FIVE CASES		
Patients who died within four years	24	
From disease of remaining kidney	12	
From pulmonary tuberculosis	7	
From miliary tuberculosis	5	
Patients who died more than four years after operation	21	
From disease in remaining kidney	9	
From pulmonary tuberculosis	9	
From miliary tuberculosis	1	
From spondylitis with paraplegia	1	
From peritoneal tuberculosis	1	

seven cases, and lymphadenitis, ten cases. There were eighty-four cases without operation in which the later results of the disease were known. Death occurred in seventy-one (84.5 per cent). Two years after onset of the disease death occurred in twenty-six (31 per cent); from three to five years after, in twenty-seven (32 per cent); from six to ten years after, in twelve (14.3 per cent), and more than ten years after, in six (7 per cent). Renal and urogenital tuberculosis and its sequels, general cachexia and uremia, are in great preponderance, forming about 80 per cent of the causes of death.

The operative mortality in 190 cases of nephrectomy for unilateral tuberculosis and the relation of mortality to the age of the patients are shown in table 1.

19. Persson, Mauritz: Renal Tuberculosis: A Clinical Survey of 295 Cases, Ninety of Which Were Not Operated On, Am. Surg. **82**:526-551 (Oct.) 1925.

Persson considers those patients as well who, three years or more after operation, have been found free from a troublesome desire to urinate, smarting pains on urination, considerable pyuria and hematuria, and who have, besides, almost totally regained their strength and power to work, and, finally, have increased in weight. In 104 cases these requirements were fulfilled so that definite cure occurred in 57.1 per cent. The observation period was from twenty-three to twenty-five years in two cases, from fifteen to twenty years in eleven cases, from ten to fourteen years in twenty-six cases, from five to nine years in thirty-nine cases, four years in sixteen cases, and three years in ten cases.

A detailed discussion of the method of wound closure is given. The best results were obtained by primary suture. In sixty-two of sixty-four cases in which the ureter was ligated and dropped into the wound and primary suture carried out, the wound was healed in a period of two weeks. Whenever any infection of the wound occurred the wound was drained usually for only three or four days. Complete data on 135 cases of wound healing is given. Of the sixty-two women who were of an age for conception, ten gave birth after operation to a total number of seventeen children. Of these nine gave birth to a total of fourteen normal children and to one fully developed, stillborn child. In the last instance, nephrectomy and, four months later, secondary ureterectomy, had been carried out during pregnancy. These nine women are now healthy and have no trace of albuminuria.

Renal Function.—Levy and Falci,[20] after an analysis of eight cases of renal tuberculosis (in four of which operation had been performed), came to the following conclusion: In bilateral renal tuberculosis, the concentration and output of urea and chlorides, worked out separately for each kidney, do not give satisfactory evidence of the function of the investigated kidney. A high percentage of urea in the blood and marked polyuria also may lead to erroneous conclusions and cause fatal mistakes. On the contrary, the study of phenolsulphonphthalein elimination gives an accurate estimation of the condition of the kidney; it should be resorted to each time intervention is considered. If the output of phenolsulphonphthalein in the least damaged kidney does not indicate a serious effort at functinal compensation, operation should be avoided by all means. In principle, nephrectomy should never be attempted in a case of bilateral disease if the remaining kidney does not excrete more than 50 per cent of the phenolsulphonphthalein in seventy minutes.

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20. Levy, R., and Falci, E.: Les indicationes de l'épreuve de la P. S. P. dans le traitement de sa tuberculoses rénales bilatérales, J. d'urol. méd. et chir. **19**:13-22, 1925.

[Ed. Note.—For many years the various correlated concentrations of salts in the blood and urine have served as an index of renal sufficiency. Many articles on the urea concentration index have appeared in French medical literature. It is of interest to note that dye excretion functional tests are becoming more popular with French urologists.]

Shaw,[21] after an extensive investigation of the elimination of phenolsulphonphthalein in normal and abnormal conditions, was able to find a definite normal curve and significant variations from this in several diseases. The normal curve of its elimination was determined by a series of forty-four tests on twenty-three normal persons in which the urine was collected at fifteen-minute intervals for two hours. The curve was characterized by an average output of 40 per cent during the first fifteen-minute period, 17 per cent during the second, 8 per cent during the third, 4 per cent during the fourth, and a gradual decrease to 0.5 per cent during the eighth fifteen-minute period.

There were one or more tests performed in the same manner in fifty-six known cases of renal disease. In all of these cases, in which renal insufficiency was demonstrated by any other tests, there were definite abnormalities in the curve and in several cases the presence of an abnormal curve indicated impending renal failure, while the other tests were negative.

A majority of the cases studied were those of renal damage from back pressure and infection. In this group a striking feature was an increase in appearance time and a delay in the peak of elimination. In the cases followed with repeated tests, the peak of elimination occurred earlier as the kidneys improved while the two hour output often remained unchanged.

The number of cases of nephritis and vascular disease of the kidney studied have been too few to justify conclusions, but the results obtained indicate that by more frequent collection of the specimens more information may be gained from the phenolsulphonphthalein test and that renal impairment may be demonstrated even when undetectable by the test as usually performed.

In most of the cases quoted, the two hour output was quite normal and in many the output in the first hour would be considered normal, yet definite variations in the fifteen minute curve were noted.

It is realized that the collection of urine specimens at fifteen minute intervals is not necessary as a routine, but in cases in which exact information concerning the kidney's ability to eliminate phenolsulphonphthalein is desirable, such a modification of the test may be useful.

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21. Shaw, E. C.: A Study of the Curve of Elimination of Phenolsulphonphthalein by the Normal and Diseased Kidneys, J. Urol. **13**:575-591 (June) 1925.

Although some of the finer points of the test are lost when collections are made at intervals exceeding fifteen minutes, for routine, thirty minute collections are practicable and give much more information than the hourly collections that are usually made. The authors think it important to date the collection from the time of administration of the phenolsulphonphthalein rather than from the time of appearance of the drug in the urine. In this way the appearance time, which is often of great importance, is incorporated in the percentage figures rather than existing as a separate entity. Examination of the abnormal curves show the advantages of this arrangement.

[ED. NOTE.—This report is most encouraging. Urologists who use the phenolsulphonphthalein test as a routine, frequently find that the results of this test do not correspond to the blood nitrogen studies. Yet simplicity makes the phenolsulphonphthalein test a desirable one for routine. With Clay's modifications in technic, some of the disadvantages of the test may be eliminated.]

Negro and Colombet,[22] after studying the nonparallel excretion of urea and phenolsulphonphthalein (what they term "le désaccord ureophtaleinique") of polycystic kidneys in several cases, conclude: (1) The elimination of urea in cases of polycystic kidney may be satisfactory in amount but its concentration never reaches a normal level (this is due to marked polyuria which accompanies this disease); (2) if the phenolsulphonphthalein is not eliminated in the same proportions as the urea, it is because the phenolsulphonphthalein, being independent of the polyuria, cannot pass in greater proportion than is compatible with the real excretory power of the kidney. The result is the "désaccord ureo-phthaleinique" and it shows also how the phenolsulphonphthalein alone indicates the exact value of the kidney. In one case this disaccord was not present; the urea retention was high (1.07 per cent) and the phenolsulphonphthalein was low, but the urinary output was poor and the patient died in uremic coma. This case, which corroborates the previous conclusions, led the authors to advance the following hypothesis: During the long period of evolution of the cysts, polyuria provokes a marked output of urea which compensates more or less for the mediocre renal power of concentration. Uremic troubles take place later while cystic degeneration progresses along with gradually diminishing diuresis. This disaccord is very marked during the period of polyuria; it then tends to disappear while diuresis diminishes. Lower excretion of urea and phenolsulphonphthalein reach a parallel level when the polyuria has ceased; their degree of excretion then remains parallel following a more and more decreasing curve until death takes place.

22. Negro, Mario; and Colombet, G.: Considérations nouvelles sur le fonctionnement du rein polykystique, J. d'urol. méd. et chir. **20**:20-26, 1925.

Rabinowitch [23] reports a study of the results in cases in which the diazocolor reaction for uremia was used. The technic of the first part of the test is identical with the van den Bergh bilirubin reaction (indirect method) except that the blood may be oxalated. To 1 cc. of plasma or serum is added 2 cc. of 96 per cent alcohol solution. The proteins are allowed to precipitate and the mixture is filtered or centrifugalized. The clear filtrate or supernatant fluid from the centrifuge specimen is collected. To 1 cc. of this clear fluid is added 0.5 cc. of alcohol and 0.25 cc. of diazoreagent freshly prepared. The mixture is then boiled for thirty seconds and then a few drops of 10 per cent solution of sodium hydroxide is added. The characteristic reaction is the very rapid development of a pink color which also disappears rapidly. The data obtained in this study showed that the reaction is positive only in cases of marked retention of nitrogen associated with definite lesions, such as advanced nephritis or acute surgical diseases of the kidney and pyelonephritis. In cases of albuminuria, hypertension, even with retinal changes and definite impairment of concentrating power, the test is negative. A negative reaction is also seen in patients with nitrogen retention due to mechanical obstruction and subsequent renal insufficiency when actual renal damage is not great. One case is cited. The patient suffered from bilateral renal tuberculosis with anuria three days before admission when the blood urea nitrogen was 90 mg. and creatinine 6 mg. for each 100 cc. The reaction was negative. A month later the blood urea nitrogen was 96 mg. and the reaction still negative. Later nephrectomy was followed by marked improvement. Then, as the urea nitrogen began to rise again, the test became positive and soon the patient became uremic and died. This is interpreted as showing at first an obstructive nitrogen retention, but as the destruction of renal tissue became more marked the reaction became positive.

[Ed. Note.—This test should be of use in distinguishing between actual renal damage and transitory damage due to back pressure in our cases of prostatic obstruction. In this way a prognosis might be quickly arrived at in some cases.]

Renaud [24] stated that nephritis in patients with cancer had usually been ascribed to intoxication by neoplastic cells. In studying the renal function in different stages of the disease, Renaud was able to make out that the nephritis was one of the most important factors causing death in cases of cancer. He also found that nephritis was not directly dependent on the neoplasm and had often the character of an accidental complication. From an anatomic standpoint kidneys of patients with

23. Rabinowitch, I. M.: Observations on the Value of the Diazocolor Reaction in the Differential Diagnosis of Uremia, Canad. M. A. J. **15**:725-728 (July) 1925.

24. Renaud, Maurice: Les reins et les fonctions rénales des cancéreux, Bull. de l'Assn. franç. p. l'étude du cancer **13**:632-657, 1924.

cancer may be classified: (1) kidneys without lesions; (2) kidneys without chronic lesions, but exhibiting lesions of toxic infectious nephritis, or with pyelonephritis by ascending infection, and (3) all the preceding kidney diseases, but superimposed on a chronic nephritis the origin of which antedated the neoplasia. In principle, patients with cancer usually have one kidney which functions perfectly normally. The nephritis can be considered as a complication of cancer. The comparison of the results given by the anatomic and the clinical study of this type of nephritis are not always in accordance; almost all postmortem examinations of kidneys show some type of lesion in cases of cancer; on the other hand, during the evolution of the cancer, the exploration of renal function shows almost no renal insufficiency and almost no symptoms of nephritis.

URETER

Surgical Technic.—Marion,[25] in a discussion of ureteral suture at the meeting of the Société de chirurgie of Paris, reports the case of a patient operated on by Petit. The right ureter was severed during removal of the uterus. The ureter was sutured end-to-end over a catheter which was left in place seven days. One month after operation, regular ureteral catheterization was instituted and continued over a period of twelve months, both to verify the permeability of the ureter and to maintain its caliber. The involved kidney remained normal and twenty months later its function was normal, and a no. 12 catheter could be inserted into the ureter. Marion states that such results are unusual. In most cases, suture of the ureter causes stenosis, distention of the kidney and later necessitates nephrectomy. A discussion on ligation and suture of the ureter in similar cases followed Marion's remarks. J. L. Faure stated that ureterocystostomy is a doubtful operation. He believes in performing nephrectomy, unless the condition of the opposite kidney is not known. Tuffier recalled the method of Israel who ligates the severed ureter which causes atrophy of the corresponding kidney. Lecené believes that this procedure is dangerous, because the ligature usually is made in septic tissues, and ascending infection, necessitating an emergency nephrectomy, may readily occur.

McArthur[26] reports the repair of a constricted ureter, the delayed result of trauma. It had been operated on previously and the kidney drained. The former renal incision was reopened and the kidney was

25. Marion: Section accidentelle de l'uretère au cours d'une hystérectomie pour gros fibrome inclus dans le ligament large droit; suture bout à bout sur une sonde urétérale; drainage abdominal, résultat vingt mois après, Bull. et mém. Soc. nat. de chir. **51**:910-919, 1925.

26. McArthur, L. L.: A New and Simple Repair of Ruptured or Strictured Ureters, Surg. Gynec. Obst. **41**:719-721 (Dec.) 1925.

found rigidly fixed by the excessive infiltration and the fatty capsule was fibrotic. McArthur describes the technic of his operation: Given a missing portion of a ureter, even 2.5 or 5 cm. in length, a longitudinal slit is made in the side of the proximal portion sufficiently long to admit two catheters. One of these, a rubber uretheral catheter, is inserted upward to the renal pelvis; the second, a ureteral catheter of good size, is inserted downward so that it passes out of the proximal fragment, and bridges the gap to the proximal end of the distal fragment. Both ends of the ureters are then approximated as closely as feasible by absorbable sutures. The catheters are then brought to the surface and permanently secured to the skin by stitches or other devices. All the urine from that kidney is thus diverted from the field of operation during the time of epithelization. The body tissues heal together around the catheter, bridging the gap between the renal and the vesical ends, and the catheter simply remains in place until in the judgment of the operator an epithelial lining has had time to grow between the ends. The catheters in McArthur's case were removed nine weeks after operation. There was no further escape of urine. The wound immediately healed and the quantity of vesical urine doubled at once. Two years later the patient was perfectly healthy.

Ureteral Stones.—Sacchi [27] says that ureteral stones may remain unnoticed for a long time although their presence gives rise to continuous trouble. He follows Marion's principle and makes a roentgenogram in every case of pyuria which is not definitely proved to be tuberculous. If this is not conclusive, an opaque catheter should be passed, and if this is unsatisfactory, a pyelogram is taken. In one of Sacchi's cases four shadows, apparently of stones in the pelvis a little to the right of the median line, did not correspond to the course of the ureter. The opaque catheter, which passed without encountering any resistance, was seen 1 cm. from the shadows. A ureterogram revealed the connection between ureter and stones which proved to be embedded in a true ureteral pouch of a markedly dilated ureter.

Lower [28] believes that the simplest and easiest avenue of approach to ureteral stone within the pelvis in the female is through the vagina. This is particularly the case when the stone can be palpated through the vagina.

The technic is simple. With the patient in the lithotomy position, the cervix is caught with a curved tenaculum and pulled well to the opposite side, thus pulling down the base of the bladder and the ureter. The stone is palpated and an incision made through the mucous mem-

27. Sacchi: Considérations a propos de quatre cas de calculs de l'uretére, J. d'urol. méd. et chir. **20**:27-40, 1925.

28. Lower, W. E.: Removal of Stone from Lower Ureter by Vaginal Route, J. Urol. **14**:113-117 (Aug.) 1925.

brane of the vagina parallel to the ureter. The tip of the index finger is then pushed through this slit and the ureter and stone are located. A tenaculum is then placed above the stone to prevent it from moving up the ureter. By releasing the traction on the cervix and by gentle traction of the tenaculum on the ureter, the ureter and stone are brought within the opening in the vaginal mucous membrane, at which point the stone can readily be removed through a longitudinal opening. The incision in the ureter is closed with a few fine, absorbable sutures and the ureter is released. A small cigaret drain is inserted through the vaginal slit and is removed at the end of the second day. If there is no leakage of urine, and there is not likkely to be, the patient can usually leave the hospital three or four days after the operation. This method affords dependent drainage, avoids external incision and shortens the period of convalescence.

Francois,[29] in three cases of calculus of the inferior extremity of the ureter in which an injection of a proprietary form of oil of cajuput above the stone and electrocoagulation of the ureteral meatus did not cause the stone to pass, removed the stone surgically; a low extraperitoneal incision was made in order to reach the ureter. Cure followed in all cases. François follows several procedures in obtaining his diagnosis of impacted ureteral calculus; first, a simple roentgenogram is taken which may reveal a shadow in the bony pelvis; second, an opaque catheter is introduced into the ureter and two roentgenograms are taken at different angles. If the suspected shadow touches the opaque sound in both pictures, one may be reasonably certain of the presence of a ureteral stone. The graduated opaque catheter (a catheter with portions opaque to roentgen rays alternating with nonopaque segments) will determine the exact site of the calculus in connection with the ureteral orifice. If the stone lies less than 1 cm. from the ureteral meatus, one may hope to have it pass to the bladder by making a slit in the ureteral meatus with electrocoagulation. If this method fails or if the calculus is higher, one must not wait too long before operation for fear of hydropyonephrosis.

[Ed. Note.—Urologists in this country use the ureterogram more frequently than the shadowgraph catheter in forming a diagnosis of ureteral stone. The nodular disposition of the opaque medium around the stone, the distention of the ureter above the obstruction and in some cases an absence of the medium above the shadow, while present directly below it, are the main points to consider in the diagnosis. A positive ureterogram together with obstruction to the catheter is usually sufficient to make a definite diagnosis.]

29. Francois: Trois cas de calculs de l'extrémité inférieure de l'uretère, enlevé par la voie parapéritonéale, Bruxelles méd. **5**:1413, 1925.

Chute [30] states that infection of the abdominal lymph nodes, which is usually tuberculous, occurs quite commonly, not only in children but also in young adults; it is occasionally seen even in older persons. The condition is subacute, as a rule, and causes vague abdominal discomfort rather than pain; however, it may at times be absolutely painless. Sometimes the pain is acute enough to lead to the removal of the appendix or to abdominal exploration. The condition is generally of less interest to the urologist than to the general surgeon. In the process of cure of these inflamed lymph nodes, calcification often takes place, as is the case in the cure of tuberculous lymph nodes elsewhere. These calcified abdominal nodes are of considerable interest to the surgeon since in their roentgenographic appearance they are easily mistaken for urinary calculi. This simulation may be very close indeed and must be constantly borne in mind in considering the nature of any shadows that have been found in patients suffering from symptoms that might be due to renal stones; the question of calcified abdominal lymph nodes need not be considered when branched coral-like shadows are seen. In carrying out roentgenographic investigation in cases in which the symptoms suggest the possibility of renal or ureteral stones, shadows are often thrown by calcified abdominal lymph nodes. These shadows can usually be easily distinguished from those of urinary stones by their mottled appearance and mobility. Occasionally the roentgenographic catheter, with or without stereoscopic plates, will be necessary to determine whether a given opaque body is in a ureter or not. Rarely a pyelogram may be necessary to determine whether a given shadow is of renal or extrarenal origin.

Marion [31] reports three cases in order to emphasize the importance of catheterizing the ureters in cases in which renal stones are being passed; relief from pain and even cure may be obtained by this procedure. The first case was that of a woman who, for three weeks, had suffered from almost constant pain in the right ureteropelvic region, eased only by morphine. The passage of the catheter relieved the patient instantaneously. The catheter was left in place for a few days and the stone was removed later without incident. In the second case a differential diagnosis between renal and hepatic colic was almost impossible. In order to help the diagnosis as well as the pain, a catheter was passed into the ureter; 17 cm. deep it struck something hard which it finally passed; a stream of urine was liberated. Pain which had been constant and severe for twenty-five days vanished immediately and

30. Chute, A. L.: The Difficulty in Distinguishing Between the Radiographic Appearance of Urinary Stones and Calcified Abdominal Glands, J. Urol. **14**:489-500 (Nov.) 1925.

31. Marion, G.: De l'utilité du catheterisme ureteral dans la colique nephritique par lithiase, Presse méd. **33**:1043 (Aug. 5) 1925.

completely. The catheter was left in place for three days, and a week afterward the stone was passed spontaneously and painlessly. The third patient had been severely ill for twenty-four hours with intense right sided renal colic accompanied by chills and high temperature. After catheterization the temperature fell to normal, the pain was abolished and the stone was mobilized. It passed spontaneously ten days later. Marion concludes that ureteral catheterization during the passage of a stone is a useful therapeutic procedure which should be more often resorted to. He says that belladonna is more satisfactory in these cases than morphine. Morphine, of course, abolishes the pain, but it stops the progress of the stone. Belladonna not only diminishes the pain effectively but at the same time helps the progression of the stone, as it suppresses the ureteral spasm without suppressing the peristaltic contractions.

Ureteral Prolapse.—Mercier [32] stated that prolapse of the inferior extremity of the ureter into the bladder is of rare occurrence. He collected reports of six cases of this disease. He added the report of one case observed in Professor Marion's service and, after a complete discussion of its etiology and pathology, reached the following conclusion: Prolapse of the inferior extremity of the ureter is often mistaken for cystic dilatation. A single etiologic theory cannot apply to it; Mercier believes that they are prolapses of "force," consequent on abnormally violent contraction of the ureter. These contractions may be caused, however, by various lesions, and a predisposing cause should be present, such as a loose union of the different layers of the ureteral wall. Cystic dilatation, on the contrary, is a congenital malformation. Prolapse of the uterus develops under the influence of a stricture of the meatus or else as a consequence of the existence of an abnormal valve, situated inside the ureter or close to its meatus, which, by closing its orifice, constitutes an obstacle to the flow of urine. No symptoms accompany the disease; it is during cystoscopic examination that it is usually found, its main feature being its easy reduction by pressure of a ureteral catheter, which distinguishes it from cystic dilatation. From a therapeutic standpoint, it is necessary to find the primary cause; treating the lesion locally may permit recurrence or persistence of the painful renal phenomena. If nephrectomy is to be performed for some other reason, intervention for the prolapse is, of course, unnecessary. If, on the contrary, the surgeon performs a conservative operation, he must secondarily act on the prolapsed mass which would otherwise be liable to institute or aggravate renal retention. This secondary intervention will have to be carried out through the urethra

32. Mercier, O.: Le prolapsus intravésical de l'extrémité inferieure de l'uretère, J. d'urol. méd. et chir. **19**:402-427, 1925.

with the cystoscope; it will consist of destruction of the mass and "meatotomy" if the ureteral orifice is constricted.

Ureteral Transplantation.—Marion [33] states that ureteral transplantation is of doubtful value. If a transplantation is performed, one should always be ready to operate on the corresponding kidney in case of complications. He suggests that in some cases, instead of reimplantation primary or secondary nephrectomy may be more desirable. He believes that, in most cases, the kidney of which the ureter has been transplanted becomes dilated and gradually atrophies. Sometimes patients do not notice the disappearance; in other cases the immediate result is good, but later complications arise which necessitate nephrectomy; finally, in other cases, the immediate result is bad and compromises the result of the primary intervention. In a period of from fifteen days to two months three of Marion's patients died. He attributed the deaths to accidents of pyonephrosis developed as the result of transplantation of the ureter. Legueu, taking part in the discussion, confirmed Marion's statements. He found only one favorable case in the literature, that of a patient who, seventeen years after transplantation of the ureter, still had a well functioning kidney.

[Ed. Note.—In transplantating the ureter for various operations on the bladder the possible preservation of renal tissue is not sufficiently important to justify the further expenditure of time during the operation. In many cases the ureter in question has already become obstructed and the corresponding kidney greatly reduced in function. Hunt [34] reported ninety-eight cases of segmental resection of the bladder with ligation and transplantation of the ureter for malignant tumors. In forty-five cases the ureter was disposed of by ligation, with six postoperative deaths, a mortality rate of 13.3 per cent. Necropsy disclosed acute pyelonephritis in all cases. Nephrectomy as a result of infection superimposed on hydronephrosis was necessary in two cases, one five days after operation followed by death, the other thirty days after operation with recovery. In fifty-three cases the ureter was disposed of by transplantation with sixteen deaths, a mortality rate of 30.1 per cent. Death occurred from the third to the fifty-third day. The clinical cause of death in each instance was ascending infection. Subsequent nephrectomy was resorted to in only one case, nine years after the first operation.

In those cases in which it is necessary to consider transplanting the ureter it may usually be inferred that the malignant disease is extensive,

33. Marion: Discussion sur les implantations ureterales, J. d'urol. méd. et chir. **20**:58-59, 1925.

34. Hunt, V. C.: Disposal of the Ureter in Surgical Excision of Malignant Tumors of the Bladder, J. Urol. **14**:19-31 (July) 1925.

and often infection is present in the surrounding tissue as well as the kidney. The high death rate is a result of the severity of the condition more than of the operative procedure. It is likely that something may be accomplished in the future in certain of these cases of extensive vesical carcinoma by total cystectomy and transplantation of the ureter into the colon.]

Pepin [35] discussed the exclusion of the urinary bladder. Deviation of urine from the bladder may be obtained either by nephrostomy or by transplantation of the ureter to the skin or to a hollow organ. Nephrostomy is unsatisfactory; it is a bloody operation, causes lesions of the renal parenchyma, necessitates drainage against gravity, and the collecting apparatus is usually fixed so that the patient cannot directly control it. Ureteral transplantation is more satisfactory. Papin gives the following facts about this procedure:

1. An isolated ureter does not become necrotic if it is not separated from its connective sheath.

2. Isolation of the ureter from its normal connections disturbs its functioning power; it becomes atonic and dilated and contracts more slowly and less frequently.

3. It is impossible to avoid the atonic dilatation of the ureter, but this develops slowly. Dilatation by stricture or kinking, which is rapidly progressive, can be avoided by correct surgical procedures.

4. All surgical procedures cause infection; the resulting dilatation of the ureter is responsible for most infections.

Papin gives three methods of transplanting the ureter. Transplantation to the skin, which is a relatively safe operation, may be carried out in the hypogastric region, in both flanks, in the lumbar region or preferably in the iliac region. One of the author's patients is still doing well after iliac ureterostomy performed five years ago. The second method, transplantation of the ureter into the urethra, is dangerous and should not be done. The third method, transplantation to the intestine, is occasionally performed but Papin considers it a dangerous operation; it causes peritonitis, acute pyelonephritis, anuria, and the mortality is high. The Mayo Clinic reports a satisfactory series of cases of transplants to the intestine; only one death occurred in thirty-five cases. This success is due to the fact that the operations were performed in two stages. In a series of operations by Russian surgeons there were sixty-one deaths in ninety-eight cases. Papin reports the following series of compiled reports: In cases of total cystectomy the mortality of transplantation to the skin was 28 per cent; to the intestine, 59.2 per cent; to the vagina, 50 per cent; to the urethra, 100 per cent (eight cases). Death occurred in ten of eighteen cases of

35. Papin, M.: La derivation haute des urines, Presse méd. **33**:1412-1413, 1925.

inoperable tumor of the bladder following transplantation of the ureter into the bowel; for the same condition death occurred in one of five cases of double nephrostomy and in seven of twenty-two cases of double ureterostomy.

Ureteral Stricture.—Kretschmer [36] reports four cases of so-called congenital stricture of the ureter. The etiology of this condition is obscure. The first case was that of a child aged 7 months. At operation a large hydronephrotic kidney was found with a stricture of the ureter about 1 cm. below the renal pelvis. Nephrotomy, not nephrectomy, was performed, because there was no proof of the presence of a normal kidney on the opposite side. After the operation all urine came through the renal wound. The patient died two weeks later. Necropsy showed bilateral hydronephrosis and bilateral stricture of the ureter. The second case was that of a male child aged 5. At cystoscopy a prompt flow of very turbid urine was obtained from the left kidney. The urine from the right kidney was clear. A pyelogram showed enormous dilatation of the right kidney. At operation a stricture of the ureter at the ureteropelvic junction was found. This patient recovered uneventfully. The third case was that of a male child aged 3. The diagnosis of stricture of the ureter with hydro-ureter, hydronephrosis and superimposed infection was made. The fourth case was that of a female child aged 7 months. A pyelogram revealed enlargement of the right renal pelvis. Bottomley reports twenty-five cases occurring in children under the age of 5; in five the stricture was bilateral. Kretschmer draws attention to the discrepancy that may exist between the urinary findings and the condition present in the kidneys, and between the symptoms and the site of disease, especially in acute cases, which makes a definite diagnosis of ureteral stricture at times very difficult before operation.

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36. Kretschmer, H. L.: Congenital Stricture of the Ureter, Surg. Gynec. Obst. **41**:713-719 (Dec.) 1925.

(To be Continued)